DYNAMICS OF FOREST PRODUCT CONSUMPTION: THE ROLE OF ECONOMIC DEVELOPMENT AND FOREST POLICIES IN WEST BENGAL, INDIA

BY

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TABLE OF CONTENTS

ACKNOWLEDGEMENTS ii

TABLE OF CONTENTS iv

ABSTRACT viii

CHAPTERS

I. INTRODUCTION 1

Recent Policy Change 4
The Research Problem and Hypothesis 6
A Conceptual Framework 7
Information and Methods of Analysis 11
    Fuelwood Requirement 12
    Industrial Wood Requirement 13
    Production Possibility of Fuelwood and Industrial Wood 15
Fodder and Nontimber Forest Products 17
Analysis of Social and Institutional Factors 19
Externalities and the Environment 22
A Profile of West Bengal 23
Organization of the Dissertation 28

II. REVIEW OF LITERATURE 31

Forest Products and their Uses 33
Nonexistent and Imperfect Markets and their Effects 34
Fuelwood 38
    Fuelwood Substitution 41
    Rural-Urban Migration 46
    Empirical Studies on Fuelwood Consumption 47
    Fuelwood Production 52
    Headloading 55
Industrial Wood 56
    Consumption of Industrial Wood 57
    Production of Industrial Wood 64
    Farm Forestry 66

Livestock and Fodder 74
Nontimber Forest Products 79
Forests and Environmental Quality 84

III. SOCIOECONOMIC AND INSTITUTIONAL ISSUES IN FOREST MANAGEMENT PROGRAMS 88

Participatory Forest Management 90
Social Forestry 90
Community Forestry Programs 92
    Reasons for Policy Change 92
    Community Management Experiences 95
    Social Organizations 98
    Interaction with the Forest Department 108
    Training 110
    Problems During Transition to Participatory Forest Management 113
    Replication of Pilot Projects 114
Farm Forestry Programs 117
    Why Plant Trees 119
        Supply of forest products for own use 120
        Meeting growing market demand 120
        Maintenance of agricultural productivity . . 121
        Risk reduction 121
    Profitability 122
    Risk Perception 128

IV. ANALYTICAL METHODS FOR ESTIMATION OF FUTURE REQUIREMENTS AND PRODUCTION POSSIBILITY OF FOREST PRODUCTS 131

Time Horizon 132
Estimation of Requirements for Forest Products 134
    Fuelwood 134
        Consumption in the base year 136
        Population growth 138
        Growth rate of per capita GNP 140
        Price and availability of substitutes 145
        Efficiency of combustion 146
    Industrial Wood 147
        Consumption in the base year 151
        Per capita GNP 152
        Population growth 156
        Literacy rate 157
        Manufacturing sector GNP 158

Estimation of Availability of Forest Products 159
Forest Types 159
Vegetation 161
Productivity 163
Land Constraint 165
Participatory Forest Management 165
Strip Plantations 166
Farm Forestry 166
Livestock 167
Nontimber Forest Products 173

V. DISCUSSION OF RESULTS AND POLICY IMPLICATIONS . . 174

Fuelwood 176
Industrial Wood 179
Policy Implications 180
Population Growth Rate 182
Income Growth Rate 183
Efficiency of Fuelwood Use 187
Availability of Substitutes 187
Opening up of Markets 188
Increase in Forest Area 188
Growth in Productivity of Forests 189
Risk Reduction 190
Infrastructure Building 191
Training 192
Emphasis on Provision of Subsistence vs.
Commercial Forest Products 192

VI. ENVIRONMENTAL CONCERNS 195

Forests and the Environment 195
Effects of Deforestation on the Environment 197
Absorption of Pollutants 197
Erosion Control 198
Measuring the Effects of Deforestation
on the Environment 200
Policy Responses 201
Biodiversity and Wildlife Conservation 202

VII. CONCLUSION AND INFORMATION AND RESEARCH NEEDS . . 208

Participatory Forest Management 208
Plantation Forestry 210
Information and Research Needs 211
Summing Up 214

APPENDICES

I. THE ARABARI EXPERIMENT 216

II. THE NATIONAL FOREST POLICY 1988 219

III. THE DESIGN OF FOREST PROTECTION COMMITTEES IN WEST BENGAL 222
  Composition 222
  Duties 223
  Functions 223
  Benefits 224

IV. ESTIMATED ANNUAL PRODUCTION POSSIBILITY UNDER DIFFERENT FORESTRY PROGRAMS 226

LITERATURE CITED 227

ADDITIONAL LITERATURE 236

BIOGRAPHICAL SKETCH 245

Abstract of Dissertation Presented to the Graduate School
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DYNAMICS OF FOREST PRODUCT CONSUMPTION: THE ROLE OF ECONOMIC DEVELOPMENT AND FOREST POLICIES IN WEST BENGAL, INDIA

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India's forests are under immense stress due to a combination of poverty and a rapid population growth that outpaces the growth in opportunities for productive livelihoods, and forces a substantial and growing population to depend directly on the forests for their livelihood. This analysis deals with the dynamics of forest products requirement and production for the state of West Bengal, India. Growth in the requirement of major forest products is a result of the interplay of economic forces outside the forestry sector, such as population growth, income growth, growth in the agriculture and manufacturing sectors, literacy rate and so on. Growth in production is jointly determined by the capacity for technological advances to increase the physical production possibility under increasingly binding land constraints, and the building of appropriate social and institutional regimes among the communities and the government to design and implement management programs at the micro level.

First, experiences from other common property and joint management systems are used to evaluate the current system in West Bengal. Second, estimates of forest products requirements over the next fifteen years under alternative scenarios of economic growth patterns are compared to estimates of physical production possibility of forest products. Finally, the externalities of the system which threaten the sustainability of the programs are highlighted.

The results indicate a widening gap between forest products requirement and production over time. As incomes grow, the relative consumption share of fuelwood declines while that of industrial wood rises, implying that the extreme emphasis on subsistence oriented management vis à vis productivity growth in the current forest policy environment will have to change over time. Further information collection and basic research are needed as inputs for more sophisticated applied research to enable informed policy formulation.

CHAPTER I

INTRODUCTION

The problem of forest management can be viewed as a classic economic problem of reconciling ends and scarce means, as defined by Robbins (1935). In forestry, the scarce means have alternative uses for different sets of users, who compete for them. This increases the complexity of the economic problem because as Arrow (1951) has shown, individual preferences can not be aggregated to develop social ordering; as he explains, it is difficult to extend the concept of individual rationality prevalent in economic theory to collective or social rationality.

The challenge of developing collective rationality through appropriate policies and programs, and simultaneously satisfying individual or group preferences, has been the goal of the forest sector policy makers in India. This research focuses on the case of the state of West Bengal in India. It looks at the effect of current programs in satisfying the needs of the consumers of forest products, both individuals and groups, over time. It also looks at the collective rationality of the programs from the standpoint of their sustainability in maintenance of the natural resource base while continuing to provide for the growing needs of the consumers. In order to do that, the consumer groups and their requirements are identified and the nature of growth in requirements over time is analyzed. On the other hand, the production possibility of the forest system under the current programs is determined, and the impediments in their design, implementation and management are analyzed. Having established the above, aspects of sustainability such as the stability of the system over time and effects of the system on the natural resource base, are analyzed to assess the collective rationality of the programs.

The immense stress on India's forests has been a result of a combination of rapid population growth and inadequate growth in opportunities for productive livelihoods, leading to a substantial and growing population depending on the forests for their livelihood. Providing for a large fuelwood requirement poses the biggest challenge in the forestry sector. According to the West Bengal Forest Department (1984), about 88% of the total wood consumption in West Bengal is in the form of fuelwood used for domestic energy, 93% of which is consumed in the rural sector. Most of this is directly collected by the households for self-consumption from public forests and common property lands free of charge. Only about 10% of the total wood produced is used by the industries.

This poses the challenge of balancing the effects of growing dependence on forests with the maintenance of a natural resource base. Over the last two decades, various management systems and programs have been devised in India to achieve a reconciliation between maintenance of the resource base and increasing the supply of forest products, while getting direct forest product consumers directly involved in the management programs to increase the supply. In the process, many lessons have been learned. The state of West Bengal has taken a leadership role in experimenting and finding success with innovative forest management practices. The performance of the West Bengal forest sector has been a matter of special interest in the international community since the early 1970s when the first experimental joint management of forests between the government and the local people was developed in the Arabari forest range (see Appendix I). The World Bank (1992) called it a famous example of successful joint management. The West Bengal Forest Department has continued to aggressively pursue innovative forest management practices, which include exotic plantations on private and common property lands and joint management of natural forests on public lands, in attempting to enhance productivity of forest products needed for subsistence of a large poverty stricken population, as well as a growing demand for industrial wood.

Recent Policy Change

The basic principles guiding forest management in India did not change until the Social Forestry Program was introduced in the 1970s. The National Commission on Agriculture, a Government of India body, evaluated the forestry sector problems in 1976 and concluded that fuelwood consumed by local communities from public lands has been greatly responsible for deforestation. To counter deforestation, this practice must be discontinued. Farmers must plant their own trees in their own lands and in common property lands outside public forests to systematically produce and satisfy their fuelwood needs.

According to the recommendation of the commission, Social Forestry programs were developed which aimed to promote production of wood on private lands and common property lands mainly for subsistence purposes. However, what really happened was that people continued to get their fuelwood from public forests and common property lands, and sold the output from their own lands as industrial wood. Therefore the basic purpose of moving towards self-sufficiency in fuelwood production and consumption did not materialize.

During this time the government found it difficult to continue enforcing restrictions on access and use of public forests and common property lands due to the pressure of increasing local demands. These demands were rising due to the declining natural resource base and increasing population, which forced the rural communities to violate government restrictions and acquire subsistence products from forest lands. The resultant unregulated exploitation led to the "tragedy of the commons" where the communities discounted the future heavily and continued unsustainable extraction.

In response, the government came up with a new National Forest Policy in 1988. This policy retained parts of the Social Forestry Program while bringing about a revolutionary policy change in the management of natural forests in the form of Participatory Forest Management. At present, the 1988 Forest Policy is the guiding force for all forest management programs, including the ones, described below, being implemented in West Bengal. (The main points of the National Forest Policy 1988 are provided in Appendix II.)

The forest management programs being currently implemented by the West Bengal Forest Department comprises of the following components:

(i) Participatory Forest Management in natural forests owned by the government, and

(ii) Social Forestry which is made up of

  (a) Strip Plantations on common property lands, and,

  (b) Farm Forestry on private lands.

Results of these recent efforts are crucial for designing future forest management strategies and overall policy formulation. But, such information is limited at this stage. Forests have a relatively long gestation period resulting in slowly unfolding observation of results. However, many decisions will have to be made now, in order to arrest the apparently widening gap between availability and requirements of forest products, and to improve the ecological state of degraded forest lands.

The Research Problem and Hypothesis

This research explores how the forest management programs being implemented by the West Bengal Forest Department will be able to meet the growing requirements of forest products, namely fuelwood and industrial wood by all user groups consisting of (i) a large number of rural people who mainly collect fuelwood for domestic energy and (ii) the industry, which purchases wood as raw material for paper, packaging, furniture and construction. Both the requirements and availability of these forest products are expected to increase over time. This research will determine how the gap between the requirement and availability of the products is likely to change over the next fifteen years by simulating a number of scenarios of rates of change in economic variables which affect their consumption, and by comparing them to estimated potential production. The result will test the hypothesis that the current set of programs will be insufficient in bridging the gap.

A Conceptual Framework

In order to determine whether the forest product requirements could be met under the management program, a set of issues that determine the requirements and the extent of success of the program from the standpoint of supply is systematically developed.

First, what are the factors that will determine the level of future requirement of fuelwood and industrial wood? Fuelwood is an inferior fuel and its predominant use can be directly linked to the interrelated effect of poverty and lack of income and employment of the population. Lack of purchasing power due to poverty prevents people from buying superior fuels such as kerosene, while the lack of employment leads to low opportunity cost of labor which makes the time consuming activity of fuelwood collection from public lands lucrative. It is apparent that income growth among the poorer sections would greatly reduce the fuelwood requirement. In the aggregate, the population growth rate affects the total fuelwood requirement in the future.

In case of industrial wood, the growth rate in requirement is determined by the growth rate of demand for household goods made of wood and the growth rate of the activity level of the manufacturing sector that uses wood as an input. The former is dependent on the growth rate of income, while the latter is dependent on the growth rate of demand for these manufactured goods which is in turn determined by the growth rates of income and population.

Second, given the constraints on resources (in this case, the total availability of land--public, private and common property, for forestry programs) and technology (in this case, technology is defined by each component of the program), there is a production possibility, defined as the maximum obtainable level of production of fuelwood and industrial wood.

Third, in the case of each component of the forest management program, namely Participatory Forest Management of natural forests on government lands, Farm Forestry on private lands, and Strip Plantations on common property lands, to what extent will the production possibility be realized? This is determined by a number of factors:

(i) The nature of the interaction between the producers, who also partly consume the products, and the Forest Department, who is initiating the program, based on the social and political environment including community infrastructures and personal preferences. The forest community is a heterogenous body in terms of wealth and assets, education, occupation, societal status and degree of dependence on forest products. There exist traditional behavioral accords between the Forest Department and the forest communities and within themselves in relation to rights and privileges of access and collection of products from public forest lands, which are different from the new partnership relation envisaged. These factors affect the institutional structure of the forest communities which are involved in this development action, and their desire and motivation to participate in forest management.

(ii) The level of organization, availability of resources, training of human resources, and forest extension that could be developed. In case of Farm Forestry, adoption of the enterprise depends on the perception of profitability and riskiness in the mind of the farmer. Risk perception is made up of production risk and price risk. In addition to output price, availability of capital, level of technical support as well as options for disposal of final products are factors that affect the adoption of Farm Forestry.

Finally, the implications of the programs for the conservation of biodiversity and other environmental concerns such as soil erosion and watershed maintenance. These factors arise as negative externalities of the system, and collective rationality requires that they are minimized. Sustainability of the system could be affected if magnitude of the negative externalities is large.

Concepts of demand and supply are difficult to define or measure in case of all forest products, with very few exceptions. In case of fuelwood there are no organized markets. It is mainly collected and directly consumed by the rural households and only a small fraction is traded. Therefore, it is a subsistence need, as opposed to a market demand. The subsistence need is a reflection of the low purchasing power of much of the rural population, 30% of which is below the poverty level (UNICEF, 1991), less than 10% is altogether landless (Singh, 1990), and about 70% constitutes marginal landowners with less than 0.42 hectares of land (Ministry of Agriculture, 1992).

In case of industrial wood, there is a market demand. However, government intervention in many forms, including subsidized supply to industries and predetermined prices for supply to government owned saw mills, distorts the market so that a competitive price can not be discerned. These market interventions do not allow prices to clear the market, and an excess demand situation prevails. The extent of excess demand, which itself is determined by the market for the finished products, and in the short run, on the installed capacity of machinery, is not revealed in the market. What is revealed is the level of consumption. Therefore, we have used the terms "requirements" and "availability" rather than using the concepts of "demand" and "supply."

It is clear from the preceding discussion that a substantial portion of the forest sector is driven by nonmarket factors. The lack of competitive markets poses a major problem in analyzing producer and consumer behavior in forest goods. Reasons behind nonexistence of markets, and distortions in the ones that do exist, will be explored later. The nonmarket nature of forest products justifies using a requirement-availability framework instead of the more insightful demand-supply model.

Information and Methods of Analysis

Literature review reveals that there is little quantitative information on the requirements of forest products and how they have changed over time. The Forest Department of West Bengal conducted a Wood Balance Study in 1984, where they interviewed 1700 households in the state to determine their fuelwood usage pattern and the source of supply. Their estimates for fuelwood consumption are available. The Ministry of Environment and Forests provides published data on the area of land under forests and also the available area for reforestation, broken down by districts. The method of estimation for these areas is not reported. Similarly, the requirement for industrial wood by industries for the same year, in the state of West Bengal, was made available by the West Bengal Forest Department.

Fuelwood Requirement

The future aggregate requirement of fuelwood is estimated in this analysis by modeling the effects of population growth and income growth as main driving forces on the current consumption of fuelwood. The effect of population growth is captured under the assumption of constant per capita consumption over time, all other factors other than population level remaining constant. The change in the population of fuelwood users is estimated using weighted average of rural and urban fuelwood users and the differential in population growth rate between rural and urban areas to account for the effect of rural-urban migration. The growth rate of population is optimistically projected to decline by the United Nations (Bos et al., 1994-95) and the Government of India (1993). The effect of population growth on fuelwood requirement is analyzed separately under assumptions of observed growth rate of the last decade as well as the optimistic growth rate that has been projected.

The effect of income growth on the fuelwood requirement follows interesting patterns. As incomes increase and people emerge out of poverty, their fuelwood usage declines as they substitute superior fuels which they can now acquire with the increased purchasing power. Income increase is also a result of increase in productive employment opportunities, which raises the opportunity cost of labor and increases the effective cost of fuelwood collection, thus reducing fuelwood consumption. The income effect is captured in fuelwood surveys in India and in West Bengal (Chakrabarti, 1989; Natarajan, 1985), which indicate a negative relation between level of income and fuelwood consumption of households. This analysis uses this survey information to capture the effect of income growth on future fuelwood requirements.

The distribution of income growth is also crucial in the determination of aggregate fuelwood requirements in the future. The substitution effect will be more pronounced if the rate of growth of income among poorer sections is higher as more people rise out of poverty and move on to superior fuels. If the income growth is heavily skewed towards the richer households which already meet their energy needs from superior fuels, the substitution effect will be small, and per capita fuelwood consumption will not decline. Therefore, this analysis will develop alternative hypothetical scenarios of the distribution of growth rate of income among income classes, to understand the effect of the distribution on aggregate fuelwood requirement.

Industrial Wood Requirement

The future aggregate requirement of industrial wood is estimated in this analysis by modeling the effect of population growth, income growth, growth in literacy and relative growth in the manufacturing sector as main driving forces on the current consumption of industrial wood. Effect of population growth on the aggregate requirement of industrial wood has been captured by assuming a constant per capita consumption, other factors remaining unchanged. Alternate scenarios, under alternate assumptions of population growth rate, as in the case of fuelwood, have been developed. The effect of income growth on the industrial wood requirement arises from increased demand for household goods made of wood, and increased derived demand due to increased demand for manufactured goods which use wood as an input. Literature discussed later shows that as incomes rise from a low level, as in many developing countries, the demand for industrial wood rises rapidly, exhibiting income elasticities well above unity. However, after significant income growth, income elasticities fall as is observed in developed countries. Ultimately, income elasticity may even be negative as consumers use wood substitutes (for example, metals). The income effect is captured in this analysis by using an elasticity coefficient from the literature which reflect an income elasticity matching the characteristics of the current Indian economy.

The rise in literacy, as observed in the last decade, is assumed to continue and is held responsible for increased paper consumption by assuming that the per capita consumption of paper by literates will remain constant over time. The GNP in the manufacturing sector in India has been rising at a faster rate than the overall GNP, which indicates that the rate of increase in demand for industrial wood in the manufacturing sector is not captured by the overall GNP growth rate. To incorporate the effect of the additional demand arising out of the manufacturing sector, the differential between the manufacturing GNP growth rate and the overall GNP growth rate has been used.

Production Possibility of Fuelwood and Industrial Wood

The production or availability analysis is performed in two parts. One is the determination of the physical production possibility of fuelwood and industrial wood at the aggregate level, over time. The other is the investigation of factors that will determine how much of the physical production possibility is actually realized.

The forest systems of West Bengal, under the current management programs, can be broken down into

(i) natural forests managed jointly by the Forest Department and the local communities,

(ii) Strip Plantations on common property lands also managed jointly, and

(iii) Farm Forestry on private lands managed solely by the landowner with technical assistance from the Forest Department.

Productivity of natural forests differs according to forest types, which primarily depend on the ecological regime of the region. Therefore, it is impossible to forecast aggregate production of natural forests in the state by summing up the estimated production possibilities of every acre of natural forest land. This analysis attempts to estimate the aggregate production possibility of forest products by dividing the state into two ecological regimes. Further disaggregation based on differences in ecological regimes would theoretically yield more accurate estimates of production possibility. However, to do that, the data on forest land available for production must also be disaggregated. The existing available data is disaggregated at the district level. Districts, however, are not broken down by ecological regimes. Therefore, the variations remain within districts as well. On the other hand, many forest lands in different districts spread over the state belong to similar ecological regimes.

The basis for dividing the forest area of the state into two ecological regimes is that the northern part of the state is hilly while the southern part comprises of plain land. Ecological conditions of the hills and the plains are distinctly different. As a result, species of predominant trees are different between the two regions. The average productivity of the predominant trees also differs clearly. In this analysis, average productivity of predominant tree species in the two regions has been used.

In the case of Farm Forestry and Strip Plantation production, average productivity measures are more reliable because they are relatively more controlled production systems than natural forests due to selective planting of species of choice, and attention to soil working, spacing etc. at the time of planting.

The area that is available to be covered by each of the above programs is provided by the Forest Department. The rates at which the programs are being implemented are also available. Therefore, it is possible to estimate the total area under each of the programs over time.

The productivity and area covered over time are used to construct a dynamic production possibility frontier.

Fodder and Nontimber Forest Products

Fodder as a forest product is particularly important because of the very large livestock population of the state. According to the last census, livestock density was 3.4 per hectare (Ministry of Agriculture, 1992). The demand for fodder, however, is difficult to define because the large majority of livestock in West Bengal is very unproductive. They are reared for the little milk they produce which is justified by the very low maintenance cost, because the animals are not provided with any fodder by the owners other than what they can obtain from open grazing. Published census figures for the livestock population are available (Ministry of Agriculture, 1992), and information on the requirements of green and dry fodder for livestock is available in the Report of the Committee on Fodder and Grasses (1989). However, the requirement of fodder for the entire livestock population is not meaningful because the improved cattle population, reared for their productivity, is very small. Maintenance of the large number of livestock is clearly not justified from an economic standpoint. Literature asserts (Singh, 1994) that if the owners were made to pay for all the costs of livestock rearing (cost of fodder and externalities due to the animals) they would drastically reduce the size of the herds and keep only productive animals. Therefore providing fodder for the entire livestock is not the concern. Clearly, policies should aim to reduce the unproductive livestock population and provide fodder for only productive animals.

To examine relations among cattle density, forest area, and grazing lands, a cross-sectional study was performed in this analysis. It revealed that cattle density and forest area were inversely related, while grazing area and forest area were directly related. These results indicate that cattle density could be partly responsible for deforestation, while more grazing lands mean less pressure on forests. However, the total grazing land is very small compared to what would be needed for the entire livestock population. Also, unreliability of the data set is easy to detect. So, the relation established is not useful for livestock or fodder development issues.

Nontimber forest products, such as edibles and medicinals, are important for the livelihood of the rural population, particularly the poor. However, their requirements are not specifically defined because their consumption is of a supplementary nature. Unlike fuelwood which is a basic necessity for household energy, nontimber forest products are consumed to enhance the standard of living. This analysis does not attempt to estimate the requirement-availability situation of nontimber forest products.

Analysis of Social and Institutional Factors

To investigate the factors that determine how much of the physical production possibility will be actually realized, careful attention to the issues of design and implementation of the programs is required. Natural forests and Strip Plantations, both of which are jointly managed by the community members and the government, and whose primary objective is to provide for subsistence, are grouped together. Farm Forestry, which is a commercial enterprise, is addressed separately.

Joint management requires building up of a previously nonexistent institutional set-up. The institutional structure in existence before the 1988 policy did not contain joint management issues. The new structure consistent with the 1988 policy will have to be different because of the basic policy change from sole management by the Forest Department to joint management. The design of such a new structure includes the issues of

(i) group formation from a heterogenous population cluster with the problem that preferences of all members may not be the same;

(ii) tenure arrangements because insecurity of tenure leads to doubts about how much the forest communities will gain in the long run, specially because the first harvest could be ten years away, and therefore how much they should invest in management of the forest is unclear;

(iii) size of the group relative to the size of the forest area, and what happens in case of varying population densities leading to differences in levels of per capita benefits among communities;

(iv) specific rules and regulations for extraction of subsistence products, and on what basis would the level of sustainable removals be determined, and how the level of permissible removals would change over time as a function of the overall health of the forest;

(v) provision of management services such as protection, distribution of benefits during harvest, including how the benefits could be commensurate with the level of management effort put in; and

(vi) conflict resolution mechanisms for conflicts within the group and pilferage by people outside the group.

Similarly, the Forest Department itself would also need a new institutional structure, including revised training programs.

During the transition to joint management, problems arise due to the temporary closure of degraded forests which affect the poorer sections most. Also, the spread of the joint management program is based on the idea of replication of pilot projects, which have been deemed successful by the Forest Department and the local community. However, a serious concern is that replicated projects are not always as successful as the pilot projects for a variety of reasons.

Literature that has been reviewed provides an extensive account of all of these factors that are crucial for such institution building, based on joint management experiences in various regions. The analysis of the West Bengal case is performed by looking at each of these factors in the community management program in West Bengal and measuring whether and how thoroughly they have been considered.

In case of Farm Forestry, this analysis reviews the experience of Farm Forestry in India and then looks at the alternative driving forces that affect the farmers' decision to practice commercial forestry. Then it looks at the profitability and riskiness of Farm Forestry, and what could be done, from a policy perspective, to promote adoption. The level of adoption will determine the extent of physical production possibility that will be realized.

Externalities and the Environment

The environmental issues comprise of externalities of forest product usage which affect the people through various ways. Among the ones more easily detected are the lowering of the water table due to the inability of barren lands to hold water, eroded soil losing its potential for agricultural or forest productivity, reduction in the capacity of irrigation tanks due to siltation, damage to crops and humans by animals due to loss of habitat, etc. Others, such as the loss of genetic base for medicinal research and development, are the more long term effects (Poffenberger, 1992).

Information on the state of biodiversity and soil and water conditions is available from the relatively advanced wildlife and conservation unit of the West Bengal Forest Department, and also from published reports of studies by local NGOs. Based on these reports, some implications of forestry programs on the environment can be discerned. Valuation of environmental effects in objective terms is a very controversial issue. Although methodologies exist for such valuation, they are more meaningful for environmental impact assessments of area specific development projects such as multipurpose irrigation and power generation projects. The scope of this research is restricted to analytical arguments that subjectively assess the effects of the forest management program on the environment.

A Profile of West Bengal

The immense population pressure on forests in the state of West Bengal, even by the standards of India, is illustrated by the fact that the per capita forest area of the state is 0.02 hectares compared to the national average of 0.12 hectares. Of the total geographical area of 88,752 square kilometers of the state, 13.4% or 11,879 square kilometers is classified as forest area. However, only 9.6% of the land is under actual forest cover (Ministry of Environment and Forests, 1989).

Among the other factors that have a bearing on the pressure on the forests, is the size, density and growth of the population of the state. Population growth leads to increased direct demand for forest products for subsistence needs of the majority of the rural population as well as the demand for manufactured goods which use forest products as inputs. According to the 1991 census, the population of the state was 67.89 million, of which 72.7% were rural and 27.3% were urban (census figures reported in Ministry of Agriculture, 1992). The population growth rate was 2.3% annually (1981-91), compared to 2.17% nationally. However, optimism is evident in the projected population growth rate, which is predicted to decline after 1991. The Government of India projects the growth rate to be 1.4% for West Bengal and 1.6% annually for the nation for the period 1991-2001 (Government of India, 1993), while the United Nations estimates a rate of 1.79% for the nation for the same period (Bos et al., 1994).

The per capita availability of forest products, other factors remaining constant, declines with the increase in population density, which, in 1991, was as high as 766 individuals per square kilometer for the state compared to 267 individuals nationally, reflecting the 2.3% annual population growth rate for 1981-91 (Ministry of Agriculture, 1992). This decline affects the poorer sections most, who are forced to meet their basic needs at the expense of forest degradation.

The basic reason for the dependence on forest products for subsistence is rural poverty. In West Bengal, 43% of the rural population were below the poverty line in 1983-84, compared to 39% nationally. These figures declined to 30.3% and 29.2% respectively in 1987-88 (UNICEF, 1990). Poverty is reflected in the large number of unemployed persons. In 1991, only 30% of the population were classified as workers, of which about 8% of the population were cultivators, another 8% worked as agricultural laborers, and about 15% were employed outside. The number of agricultural workers has gone up by 2.5% over the period 1981-91, which is about the same as the population growth rate. Employment outside the agricultural sector has increased at 3.35% during the same period.

Poverty in a primarily agrarian economy as in rural West Bengal, is also reflected by the size of holdings. In 1985-86, the state had over 5.2 million farm families with an average farm size of less than 2 hectares. Two-thirds of the farms are less than 1 hectare. The average size of holdings declined from 0.99 hectares to 0.92 hectares between 1977 and 1986 (Ministry of Agriculture, 1992). The average net returns for area under rice cultivation, the predominant crop in West

Bengal, increased from Rupees 1,150 (US$ 120[1]) per hectare in 1978-79 to Rupees 3,562 (US$ 275) per hectare in 1986-87 (Ministry of Agriculture, 1992). However, it is significantly below the national average for area under rice cultivation which stood at Rupees 5,335 (US$ 410) in 1986-87. This is in spite of a 9.7% annual rate of growth in yield in West Bengal, compared to 5.4% nationally, reflecting increased double and triple cropping. This is consistent with the fact that the per capita income of West Bengal continues to be low at about Rupees 3,000 (US$ 100) (World Bank, 1992).

The role of encroachment of agriculture on forest lands is difficult to measure because increase in sown area does not necessarily imply encroachment. The net sown area of the state was about 63% of the geographical area in 1991. The 7% per year increase in production of rice, which is the primary agricultural crop in West Bengal and occupies more than 90% of the sown area, between 1981 and 1991, has been a result of a number of factors including

(i) a 2.08% annual growth rate of area under cultivation

(ii) a 9.7% annual growth rate in yield, compared to 5.4% nationally,

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[1] The exchange rate between Indian Rupees and US Dollars has changed significantly over time. The dollar figures in parenthesis throughout this document reflect the exchange rate prevalent at that time.

(iii) a 4.5% annual growth rate in cropping intensity indicating increase in double and triple cropping,

(iv) a 5.11% annual growth rate in irrigation,

(v) an 11% annual growth rate in use of fertilizers (compiled from figures in Ministry of Agriculture, 1992)

Growth in the agricultural sector is of particular importance to the forestry sector because development in agriculture and the related increase in rural income would reduce the dependence on forests for subsistence needs, as households use the additional income to purchase superior goods, such as kerosene in place of fuelwood. This effect is multiplied when improved employment opportunities raises the opportunity cost of labor to make subsistence activities, such as fuelwood collection, uneconomic. Therefore, growth in income and employment and per capita income and the consequent decline in poverty are key to forest sector development. However, increased income would also lead to increased demand for manufactured goods that use forest products as inputs. The Wood Balance Study estimated that in 1990, 88% of the total wood consumed in the state was in the form of fuelwood. Therefore, current forest sector policies must focus more on the fuelwood issue. However, with increased income, the relative focus will have to shift toward industrial wood. We shall look into these interactions in a dynamic framework in later chapters.

Organization of the Dissertation

The second chapter presents a review of the relevant literature. It looks at the important forest products and the nature of their consumption for both commercial and subsistence purposes. The nonexistence or imperfection of forest product markets does not allow price responses to clear the market. So, the reasons for market failure and its consequences are examined. Then, a review of the consumption and production patterns of fuelwood and industrial wood, and methodologies that have been used to estimate their future consumption, is presented. Finally considered is what the literature has established about the effects of forest management on the quality of the environment.

The third chapter provides a sociological and institutional analysis of the impediments in designing and implementing the new forest sector policy which involves joint management between the community and the government and private plantations. The analysis in this chapter provides an understanding of the relation between social organization, institution building, technical support, etc. and how that determines the extent of the physical production possibility that will be ultimately realized.

The fourth chapter presents the design and methods of the analysis to estimate the path of future requirements and production possibility of forest products, under alternative scenarios.

The fifth chapter deals with the results of the analysis performed in this study. First, estimates for the requirements and potential production of fuelwood and industrial wood until the year 2010, in five year intervals, under alternative scenarios, are presented. The estimates are compared to provide an understanding of the nature of expected change in the gap between availability and requirements of forest products. Based on the results, policy implications are drawn for reducing the shortage of forest products in the future. Insights are provided to help prioritize future policy thrusts based on the predicted relative magnitudes of the different forest sector problems. The sixth chapter provides evidence of how externalities arising out of forest management practices have been affecting the environment. Arguments calling for further efforts toward internalizing these externalities are made, and the success of the West Bengal Forest Department in doing so is evaluated. The linkages between some of the environmental effects and other production systems are explored and examples provided to understand the significant magnitude of these effects.

The dissertation ends with a look at the future of the India forestry sector and identification of information gaps which seriously hinder research on the dynamics of the Indian forestry sector. Both information collection and basic research are needed in crucial areas, which would allow for more sophisticated applied research to enable informed policy formulation. Some of these crucial research needs are presented.

CHAPTER II

REVIEW OF LITERATURE

The purpose of this chapter is threefold. First, it is a synthesis of the available information base for an overall understanding of the nature of consumption of forest products in West Bengal including the economic forces, or lack thereof, behind the consumption patterns. Second, it brings together various different analytical methods that have been developed and applied by researchers around the world to investigate issues related to consumption of forest products, including the forecasting of future consumption and the determining of economic variables that affect consumption, both at the micro and the aggregate levels. Finally, it establishes the interactions between forest management practices and the attributes of human livelihoods, such as dependence on nontimber forest products, fodder requirements, and the quality of the environment.

The chapter is organized in the following sequence. It starts with a look at why consumers obtain many forest products through nonmarket mechanisms. The reasons for the nonexistence of markets or imperfections in those that exist and what its implications are in terms of valuation, and the perceived discount rate and sustainability of consumption patterns, are explored.

The following sections deal with each of the important forest products. In the case of fuelwood, the nature of consumption and the issue of fuelwood substitution in response to income growth is established. The designs and results of surveys and analytical studies on fuelwood consumption behavior are presented. Production possibilities and prescriptions for increased production are discussed. In the case of industrial wood, a similar sequence is followed. Studies on consumption behavior reveal suitability of alternate analytical methods that could be used. In the case of production, a large share is expected to be provided by Farm Forestry operations. Therefore, the experiences of private tree farmers in India and in other developing countries are recounted.

Literature asserts that nontimber forest products are important for the livelihood of the rural communities. The level of dependence and the implications of current forest management programs on the sustainability of nontimber forest products availability, as available in the literature, are presented. The following section brings out the nature of the immense problem of fodder and livestock, and its implications for establishing sustainable forest management systems. Finally, the state of the environment and the role of forest management in altering that state, and its implications for human welfare are discussed on the basis of observed interactions.

Forest Products and Their Uses

The main uses of forest products in the state of West Bengal can be categorized in the following way:

(i) Products which are commercially traded include wood for paper mills, packaging, construction, furniture, match making and poles for rural house building.

(ii) Products which are mostly acquired through nonmarket mechanisms include fuelwood as a source of energy in rural areas, fodder for livestock, and various nontimber forest products primarily in the rural areas to supplement dietary needs and a very limited income generation.

As we shall see in the following sections, available information indicates that the requirements for the above forest products have been increasing over time, whereas the availability has not matched the increased requirement. Economic theory suggests that the excess demand would be eliminated by an increase in prices. However, markets for all forest products are either imperfect or nonexistent and therefore the excess demand is not eliminated in a market process.

Nonexistent and Imperfect Markets and their Effects

The nonexistence of markets and imperfections in those that exist are responsible for our limited knowledge of the dynamics of production and consumption of forest products in India. Also, as a result, the value of forest products by the users is not correctly revealed and can not be easily measured. Therefore, application of the concepts of demand and supply in the analysis of forest products dynamics is difficult, and leads to imprecise information used for developing forest sector policy.

To function well, markets require certain fundamental conditions to be met. Property rights over all resources must be clear and secure. All scarce resources must enter active markets that price them according to supply and demand. Actions should not have significant externalities. Competition should prevail in the markets for private goods. Myopia, uncertainty, and irreversible decisions must not arise. If these conditions are not met, the free market fails to allocate resources efficiently over time. It wastes too much of resources today and leaves too little for the future (Panayotou, 1993).

A good deal of market failure such as failure arising out of unpriced and open access resources, insecure tenure, and uncertainty and high transaction costs occurs because of government failure to establish the legal foundations of markets, such as secure property rights and enforcement of contracts.

Therefore, typical reasons for market failure can be attributed to

(i) ill defined or nonexistent property rights,

(ii) unpriced resources or absent or thin markets,

(iii) high transaction costs that discourage otherwise beneficial exchanges that would conserve resources and improve social welfare,

(iv) imperfections due to fragmented markets due to barriers to resource mobility,

(v) short planning horizons of producers and consumers, discount rates that are too high arising from poverty, and individual uncertainties, and,

(vi) uncertainty, which particularly affects the poorer people, and leads to unwillingness to undertake additional investments that are otherwise profitable but have a large variance of returns.

When markets fail, prices, if they exist, do not respond to the increasing scarcity of resources. As a result inefficient use continues. Available less harmful substitutes are not used, and there are no incentives for conservation or for investment in technology to develop new substitutes (Panayotou, 1993).

Although access to fuelwood and fodder resources in public lands in India were guided by traditional institutional forces, the system has gradually broken down, as we shall see later. As a result, access has been unrestricted, and therefore resources fit the category of open access resources. As Runge (1986) points out, common property as an institution must be distinguished from free and open access where there are no rules regulating individual rights. Ciriacy-Wantrup (1975) corroborates that absence of any rules for the management of resources would result in open access resources. There is no market and therefore no price for open access resources because there is no secure and exclusive owner who could demand such a price. Consumers are unwilling to pay a price as long as they have free access to the same resource elsewhere. The price that fuelwood from open access resources command reflects only the opportunity cost of labor and capital used in their production and not the opportunity cost of scarce natural resources used in their production. The implicit rent or the user cost of the forest itself is still taken to be zero, regardless of the scarcity and social opportunity cost (the value to society for foregone alternative uses).

Most urban wood fuel markets in India are still supplied by mining natural tree stocks, with producers paying nothing for the raw material, so that the cost of fuelwood delivered to the market consists mainly of transport costs (Dewees and Saxena, 1993).

Panayotou (1993) explains that in this situation, the market rate of interest (discount rate) fails to reflect the society's true rate of time preference. A combination of poverty, impatience and risk, which either does or does not apply or applies to a smaller degree to a society as a whole than to individuals, drives a wedge between the private and social discount rate. Because of its continuity and risk pooling capacity, a society tends to be less short-sighted than its individual members. Environmental and market uncertainties coupled with a short and uncertain life span lead people to adopt short time horizons and discount rates, which results in short sighted decisions in pursuit of survival or quick profits at the expense of long term sustainable benefits. At subsistence levels at which peoples' very survival is at stake, a hand to mouth economy prevails in which the future is infinitely discounted. This results in the over-exploitation of natural resources and under-investment in their conservation and regeneration, which ultimately lead to their depletion.

Exploitation of common property or open-access resources is equivalent to the use of an infinite discount rate. That is, future benefits sacrificed by current resource use are infinitely discounted, and effectively assigned a zero value by the common "owners," regardless of their value to society. This is understandable, since, for the open access resource, no one is assured of the benefits of their investments and conservation efforts since others have free access to the same resource. Under open access, there is no future: common property is transformed into private property through prompt capture and use. From the individual's point of view, conservation is meaningless and irrational under open-access conditions (Panayotou, 1993).

The above discussion clearly implies that the forest sector problems in India are not simply an issue of excess demand. Emphasis is required on increased productivity as well as the building of institutions that will manage the resources sustainably.

Fuelwood

The demand for fuelwood is predominantly a subsistence demand as opposed to a market demand. In the rural areas fuelwood is collected by family members, mostly women and children, from nearby common property areas and public forest lands. The collected fuelwood is used by the family to meet its entire energy need (World Bank, 1992).

The shortfall in forest products is most pronounced in the case of fuelwood. Cernea (1989) states that the urgency of the problem is illustrated by the fact that the majority of humankind still uses fuelwood as the main source of cheap everyday energy. The fuelwood needs of the growing population appear to have exceeded the regeneration capacity of the shrinking forests. Without adequate new planting, deforestation would lead to a fuelwood scarcity with profound socioeconomic and environmental consequences. Barber Conable (World Bank, 1991), in his foreword to the Forest Policy Paper also identifies the two key challenges in the forestry sector--to slow the alarming rate of deforestation and meet the rapidly growing demand for fuelwood in the developing countries.

The National Council for Agricultural and Economic Research (NCAER) did an extensive survey on the fuel requirements of the Indian population in 1985. The results have been reported by Natarajan (1985). The survey included a cross section of 13,010 households from all over the country. The Wood Balance Study (West Bengal Forest Department, 1984) also estimated the fuelwood consumption in

West Bengal, and projected future consumption, based on population growth.

Natarajan (1985) reports the widespread use of noncommercial energy in the household sector in India. He found that on a national basis, about 90% of rural household energy came from noncommercial sources, which included fuelwood, crop wastes, dung cake, charcoal and gobar gas. Although the use of noncommercial fuel declined with income, even among the highest income group considered (above Rupees 18,000 yearly), only 17.6% of the fuels were commercial fuels. In the urban areas, the share of commercial fuels increased with the size of the town. For towns with more than half a million people, 75.4% used commercial fuels, while in towns with less than 20,000 inhabitants, only 39% used commercial fuels.

In rural West Bengal, 93.6% of all noncommercial fuel used, mostly fuelwood, was directly collected. The Fuel Policy Committee (1974) reported that on a national basis, 91% of all fuelwood consumed came from unrecorded fellings. Chakrabarti (1989) corroborates this picture from a finding of the Wood Balance Study, that in West Bengal only 0.7 cu.m. or 7% of the total fuelwood consumption of 16.85 cu.m., in 1984, is accounted for from recorded production. Therefore, the consumption-supply ratio for West Bengal is 24:1 compared to 9:1 nationally (Chakrabarti, 1989). It is evident that the recorded production of fuelwood gives a misleading picture of the fuelwood situation.

The Wood Balance Study by the West Bengal Forest Department (1984) claims that the total demand for fuelwood in 1984 was estimated to be eight times more than the total demand for wood for industrial uses. Of this, more than 80% was for household uses, making fuelwood the predominant source of domestic energy in the rural areas and among the poorer sections in urban areas. However, the distribution of fuelwood used for domestic energy is heavily skewed towards the rural sector compared to the urban sector. The study estimated that 93% of all fuelwood is used in the rural sector. Other forms of noncommercial energy sources such as agricultural residue and dung cakes are also used mostly in the rural sector. In the urban areas, commercial fuel such as kerosene and liquid petroleum gas (LPG) is mostly used.

Fuelwood Substitution

There is ample evidence in the literature of fuelwood substitution following increase in per capita income. It can be argued that fuelwood used for domestic energy is an inferior good. Therefore, as incomes rise, people switch to more superior fuels such as kerosene. However, due to the subsistence nature of the demand, aggregate consumption does not vary significantly with household income at low levels of income. When the average household income rises substantially, a drop in consumption is observed (Dwivedi, 1994). Dwivedi estimates that doubling of income leads to only a 10% drop in consumption.

Anderson (1987) and Allen and Barnes (1985), in studying fuelwood consumption patterns in African countries, find similar patterns. Although the growth in per capita income is expected to encourage a shift to commercial fuels, in low-income countries the effect is weak. Studies by Spears (World Bank, 1983) have shown that even if the demand for fuelwood in African countries could be reduced by 20 to 30 percent by conservation and substitution of other fuels, a fifteen fold increase in fuelwood production would be required to meet the demand by the year 2000.

Natarajan (1985) found that on a national basis, only 1.35% of households surveyed had shifted from one fuel to another in the last five years as a result of income growth. However, of those who shifted, 65% were fuelwood users and only 7% were kerosene users. The fraction of households who shifted increased with household income. More households in the urban areas shifted fuels compared to the rural areas. In West Bengal, the fraction of households switching fuels in the last five years stood at 5.28% in the urban areas and 0.78% in the rural areas. Chakrabarti (1987) reports that in West Bengal the decline in per capita fuelwood use is most pronounced between households with an annual income of Rupees 3,000-6,000 and Rupees 6,000-12,000.

It is possible that the marginal rate of substitution between fuelwood and other improved fuel such as kerosene at the average income level of rural households is very small. Additional income is used to purchase foodgrain, to repair houses and to obtain luxuries such as bicycles and radios. This behavior may be explained, at least partially by the norm that spending decisions are taken by the head of households, who are men, while the collection and use of fuelwood are performed by women and minor children. As a result, the decision makers do not perceive any additional utility from the use of improved fuel.

The price elasticity of demand for fuelwood is not defined for rural households. Since there are no fees for collecting fuelwood from common property land or public forests, it can be argued that the value of collected fuelwood is lower than the cost of purchasing fuelwood and higher than the opportunity cost of labor. In many areas, it is reported that due to deforestation, collection of fuelwood has become more time consuming over the years, as the collectors have to travel greater distances because of inadequate availability of fuelwood from adjoining lands. However, due to the low opportunity cost of labor the practice continues. Therefore, the inelasticity of fuelwood consumption is clearly linked to rural poverty.

Dwivedi (1994) and Saxena (1994a) note that a drop in fuelwood consumption may also suggest nonavailability of fuelwood due to extreme degradation of forests, instead of income growth. In some areas, the West Bengal Forest Department has found that fuelwood shortage due to deforestation has led to rural families using shrubs and bushes along with fuelwood for domestic energy (Poffenberger and Sarin, 1990). This situation is of concern because shrubs and bushes are inferior to fuelwood as fuel. A much larger volume of shrubs and bushes is required to produce equivalent amounts of energy. Extraction of larger volume of shrubs and bushes would lead to increased land degradation. They also produce more air pollution and smoke inside the home, which would have adverse effects on health.

Consumption of kerosene clearly exhibits characteristics of a superior fuel. Natarajan (1985) found a positive correlation between kerosene consumption and household income and an inverse correlation between kerosene consumption and the average distance that household members must travel to purchase it, and with kerosene price. Rural-urban population ratio and per capita income positively affected the level of kerosene consumed for heating, while the relative price of kerosene to other fuels had a negative effect. In case of kerosene used for lighting, he found a positive relation with per capita income and negative relations with number of households electrified and the number of literates. The use of LPG in rural India is small. In West Bengal, 94% of rural households reported that LPG was not available to them.

Kerosene is generally not available for daily use in rural areas in India. The price of kerosene is statutorily fixed by the government and distributed through government outlets. For outlets in rural areas, a transportation cost is added to the statutory price, which in West Bengal, averages at 50% of the statutory price (Natarajan, 1985). Kerosene also requires investment in a stove which, unlike fuelwood stoves which can be put together by the family members themselves using free inputs, must be purchased. The cost of stoves further deters substitution. But even for relatively better-off rural households, the principal constraint to the substitution of these alternatives is the lack of regular supply through the regulated government outlets, and the lack of policy that would promote their use over fuelwood. Where markets exist, prices paid for fuelwood are rarely less than equivalent costs of energy from electricity, kerosene, coal, or bottled gas (Molnar et al., 1992). This reinforces the hypothesis that one of the deterrents of fuelwood substitution is their acquisition through primarily nonmarket means.

Rural-Urban Migration

Another factor that affects the changing requirement for fuelwood is rural-urban migration. In West Bengal, between 1981-1991, the proportion of rural population declined from 73.5% to 72.6%, and the population grew by 29% in the urban areas compared to 23% in the rural areas (Ministry of Agriculture, 1992). The urban population consumes less than 7% of the total fuelwood consumption, according to the Wood Balance Study (West Bengal Forest Department, 1984). It is likely that after migrating to an urban center, substitution by other forms of fuel such as kerosene occurs. This can be explained by a number of factors:

(i) little or no fuelwood is available for collection in the urban areas, forcing the consumer to buy fuelwood for a price,

(ii) kerosene is usually more freely available than fuelwood,

(iii) kerosene is a more efficient fuel and the effective cost of using kerosene is comparable to fuelwood, and

(iv) the opportunity cost of labor, even for women and children, is positive due to better employment opportunities, and is likely to be higher than the price of the fuelwood they would be able to collect.

Empirical Studies on Fuelwood Consumption

Mahendra et al. (1992) did a survey among 11 villages in Uttar Pradesh to determine the factors affecting fuelwood requirements of a household. Although they describe that population, climate, traditions, food habits, income, availability, cost of substitutes, occupation, household size, land holding and cattle population are relevant independent variables for consideration, their linear regression model, with annual fuelwood consumption per household as the dependent variable, includes only the following independent variables:

(i) distance of the household from forests, which had significant negative effect on fuelwood consumption suggesting forests are the main source of energy,

(ii) household size, which, as expected, had a significant positive effect on the level of consumption,

(iii) household income, which had no significant effect suggesting that fuelwood was not purchased at all,

(iv) household landholding, which was not significant suggesting that agricultural waste was not used as alternative fuel, and

(v) cattle size, which had a negative effect suggesting that owners have a trade-off between fuelwood collection and fodder collection.

Panayotou and Sungsuwan (1989), investigating the causes of deforestation in Thailand, formulates the demand for fuelwood as a function of the fuelwood collection cost, population growth/density, accessibility of forests and opportunity cost of labor. The collection cost and accessibility of forests are proxies for the price of fuelwood, the population growth directly increases the number of fuelwood users, while population density is a measure of the surplus labor available for fuelwood. They do not expect the opportunity cost of labor to have significant explanatory power because of surplus labor and stagnating rural wages in Thailand. This situation is quite comparable to that of West Bengal. The fuelwood demand model was used as part of a larger model to investigate causes of deforestation, and was not estimated separately. However, the formulation provides us with intuitive explanations of the fuelwood consumption behavior of rural households, similar in many ways to those in West Bengal.

Bhagavan and Giriappa (1987), in a study of fuel usage in Karnataka, specify income, size, fertility and irrigation potential of land holdings, and available household labor, as determinants of which fuel is used by households. Their specification emphasizes that in rural India, the fuel situation, which is a major concern in the forestry sector, is inseparable from the concerns of the agricultural sector such as food, fertilizer, land and labor situations.

Amacher et al. (1993), from case studies on fuelwood use in Nepal, contend that demand for subsistence products is the leading cause of world deforestation. They did a regression analysis to estimate household fuelwood consumption with collection time as a proxy for price of fuelwood, use of improved stoves, household income, and family size as explanatory variables. Due to lack of markets for fuelwood, collection time was used as a proxy for price. This variable had a negative sign but with a small elasticity, more so for low income households, suggesting that fuelwood is a necessity. Improved stoves were found to reduce fuelwood consumption. The coefficient for household income was positive but small for poorer households, but changed to negative for richer households. They conclude that the general inferior nature of fuelwood consumption has favorable long-run implications for the forest sector. As the economy grows and household incomes rise, the poorer households will behave more like higher income households and consume less fuelwood and draw less on indigenous forests. Their study also found that as collection time increased, poorer households used more residues as fuel.

Cecelski (1979) discusses the issues of price elasticity and income elasticity of fuels in developing countries. She finds little data to determine price elasticity of fuelwood because they are mostly not formally traded. In case of income elasticity, she finds ample evidence that as income increases, the first step is an increased consumption of kerosene, but this in turn is abandoned in favor of electricity and gas, as incomes increase further. She finds that in Pakistan, income increase leads to reduction in consumption of fuelwood, dung cakes and then kerosene in favor of electricity. In Mexico City, as incomes rise, wood and coal are no longer used. In Sudan, among the poor, income rise is followed by demand shifts to kerosene, while for middle and higher income groups, energy consumption shifts to electricity.

Estimates of fuelwood consumption on a national basis in India exhibit large variations. Dwivedi (1994) reports five different estimates by different researchers performed between 1989 and 1994, which vary from 150 million tons to 300 million tons annually. Deepak Sarmah (Government of India, date unavailable) reports that the State of the Forest Report (Ministry of Environment and Forests, 1987) estimates fuelwood consumption of the country in 1987 to be 157 million tons based on projected figures for per capita consumption and population. He also reports estimates by the Planning Commission, 1986 of growth rate of fuelwood demand at 2.1% yearly from 1990 - 2001. Another estimate by the "Working

Group on Minimum Domestic Energy Requirement" made in 1989 is 2.9% yearly from 1987-90 and 2.5% from 1990 to 2000. Singh (1981) cites estimates of fuelwood consumption growth of 2% per annum during 1970-1985 and 0.75% per annum during 1985-2000, made by the National Commission on Agriculture, 1976. The large variations among the studies indicate lack of reliable information on fuelwood needs of the nation.

To estimate statewide demand for fuelwood, the Advisory Board on Energy, (Government of India, 1985), used the NCAER Fuel Survey finding that 56% of useful energy in rural households came from fuelwood, and assumed that it will hold in the year 2004/2005. They specified that per capita energy demand is 650 kilocalories per day and also assumed that efficiency of fuelwood combustion is 8%, and calorific value of fuelwood is 4750 kilocalories/kilogram. Then, fuelwood consumption per year would be 650* Rural Population * 365*0.56 million tons/(4750,000*0.08). Their estimate for West Bengal is 9.5 million tons in 2004/2005. Additional requirement for substitution of dung cake (dung to be left for use as fertilizer) is 4 million tons, for a total of 13.5 million tons.

Consumption reduction strategies by promoting more efficient usage of fuelwood are supported by a number of experts. Chakrabarti (1989) finds that the thermal efficiency of regular fuelwood stoves is 10%-12%, whereas efficiency of improved stoves can be 30%-50%. Bowonder et al. (1988) support promotion of fuel efficient stoves, but claim that it is not happening because of

(i) absence of infrastructure for widespread dissemination,
(ii) little government support,
(iii) lack of funds for program development,
(iv) designs unacceptable to users,
(v) lack of women's participation in extension programs,
(vi) lack of trained personnel, and
(vii) lack of awareness for fuelwood conservation.

Fuelwood Production

The West Bengal Forest Department expects the supply of fuelwood to increase due to efforts towards increased production through innovative silvicultural and management techniques. Specifically, Participatory Forest Management programs in the natural forests are expected to provide a higher and steady flow of fuelwood after allowing the initial time required for the forest to regenerate naturally and through supplemental plantings. Farm Forestry on private lands, even if practiced for commercial sale of timber, is expected to produce, on an average, 2 tons per hectare of fuelwood annually from twigs and branches and from trees which do not reach the acceptable size for industrial wood. Strip Plantations on common property areas are also expected to provide fuelwood, along with timber and fodder (World Bank, 1992).

The Advisory Board on Energy (Government of India, 1985) state that the expected yield from Eucalyptus in degraded lands in West Bengal is 3 tons/hectare/year. Total available land for Social Forestry plantations is 1.759 million hectares, so the required yield to meet the entire demand of 13.5 million tons from Social Forestry would be 7.67 tons/hectare/year. They firmly believe that in reality only 50% of the land could be productive, so the average yield must be 15.34 tons/hectare/year to meet the demand. If all the 1.18 million hectares of reported forests in West Bengal are brought into production of fuelwood at the rate of 3 tons/hectare/year, the required yield from plantations (still assuming 50%) reduces to 12 tons/hectare/year, which is a formidable target.

Singh (1981) explains conditions that are important for the quick adoption of Social Forestry programs among farmers to meet the growing demand. The important factors, according to him, are:

(i) technical feasibility--plantations that can be developed using indigenous technology,

(ii) simplicity of operation--so that the farmers easily understand the functioning of the system,

(iii) profitability--intuitive cost-benefit analysis must prove its desirability,

(iv) low cost--so that the farmers do not need to invest large amount of resources, and

(v) social acceptance--the program should be consistent with the community environment.

Pant (1981) prescribes the following for increasing the production of noncommercial energy:

(i) protection of forests,

(ii) harvesting must be efficient with minimum waste, and

(iii) genetic improvements in plantations,

He also emphasizes the need to pursue substitute technology such as bio-gas.

Bowonder et al. (1988) argues that the factors affecting tree plantation in wastelands are

(i) absence of village level nurseries,

(ii) absence of forestry extension education to farmers, and

(iii) lack of institutional arrangements for involving large industries in wood plantations.

Headloading

The poorest families in rural areas engage in an activity known as headloading. Headloaders are usually women and children who collect fuelwood in excess of their domestic needs, for cash income. Fuelwood sale is unorganized. Middlemen who operate as cartels, use their monopsony power and offer a "take it or leave it" price, which varies from location to location. The fuelwood is usually carried to urban centers for retail sale. The retail price also varies from Rupees 200 per quintal to Rupees 800 per quintal depending on the amount of fuelwood which reach the urban center for sale (World Bank, 1992).

Bowonder et al. (1988) reports that the ratio of price index of fuelwood to consumer price index increased from 1.16 to 1.66 during 1977-1986. Ratio of fuelwood to food price index rose from 1.099 to 1.64. This is an indication that fuelwood is becoming relatively costlier, which may be interpreted as a sign of increasing scarcity, which in turn implies that existing forest management is not sustainable. Bowonder et al. claim that in 1987, the urban consumer had to pay twice as much for fuelwood as for kerosene per unit of useful energy. But the practice continues because, according to the researchers,

(i) poorer sections still consider fuelwood to be cheaper,

(ii) a fuelwood stove can also be used for burning wastes, and,

(iii) kerosene stoves cost ten times more than fuelwood stoves.

Industrial Wood

Industrial wood is used for a variety of purposes of which the most important ones are paper and match making, for packaging material, house building and other construction activities, industrial equipment, and office and domestic furniture. The major saw mills and plywood factories are located in the northern part of the state where much of the wood comes from. Paper mills are located in the south around the city of Calcutta, the capital of the state (World Bank, 1992).

Consumption of industrial wood relative to fuelwood is a good indicator of a nation's overall development, according to Mahendra and Maithani (1986). They compare the relative share of consumption of industrial wood and fuelwood among five major wood producing countries in Asia--India, China, Indonesia, Japan and Turkey. They find that between 1972 and 1983, the share of industrial wood in India went up from 7.67% to 8.56%, compared to 25% to 33% in China, 17% to 7% (reduction) in Indonesia, 95% to 98% in Japan and 15% to 22% in Turkey. They suggest that policies should promote short rotation high calorie crops for fuel, and improved technologies for rational utilization of wood as raw material for industries.

Consumption of Industrial Wood

Pioneering research on estimating future consumption of industrial wood was done by Gregory (1966). His work forms the basis for all future research in this area, including the methods used by the Food and Agricultural Organization (FAO) for projecting industrial wood demand.

Gregory explains the lack of consensus on terminology used to measure consumption of industrial wood. Estimates of wood needs are termed as "requirements," "potential requirements," "projected demand," or "consumption," but they all refer to the same thing. In order to avoid using the terms "demand" or "potential demand" in a noneconomic sense, the United States Forest Service calls it "potential timber requirements," and Food and Agricultural Organization (FAO) calls it "estimated requirements."

In products for which markets are nonexistent or poorly organized, such as industrial wood and fuelwood, neither the production costs nor the prices are precisely measurable in monetary units. The imaginary intersection of the demand and supply curves are synonymous with consumption, so Gregory (1966) uses that term.

The only estimate of industrial wood demand in West Bengal is available from the Wood Balance Study (West Bengal Forest Department, 1984), which derived estimates for demand for industrial wood from national figures applied to population projections of the state of West Bengal. The estimates deduced a consumption level of 60 cu.m. of roundwood equivalent per thousand people in 1990. They assumed that this demand will remain constant till the year 2000, and it will rise to 110 cu.m. by the year 2015. The per capita consumption of pulp and paper was estimated to be 3.2 kilograms in 1990, increasing to 4.4 kilograms in 2000 and 6.9 kilograms in 2015, assuming fluctuations in wooden fiber content as a function of expected fluctuations in agricultural waste fiber availability. These are one-time estimates and therefore do not throw light on the dynamics of consumption. However, such lack of information has been a long-time problem as explained by Gregory.

Gregory (1966) states that although derivation of statistical demand and supply functions is theoretically possible, using independent variables such as price, income, population level and others, the data required for such analyses are seldom available, even for major wood products such as lumber in countries as industrialized as the United States. In the face of such deficiencies, it is downright impossible to estimate demand and supply functions per se.

Gregory formulates a theoretical consumption function for industrial wood as a function of population, income, urban/rural population ratio, area of forest land, forest growth rate, cost of production and availability of competing material. Price, the key variable in most analyses of demand, is not a variable influencing consumption in the usual sense. This in no way signifies that price is unimportant, nor that price is unrelated to consumption. Consumption measures exactly the same point--the intersection of the demand and supply curves--so one can still estimate future consumption, not price, by ignoring price.

Gregory incorporates the effect of population by using both consumption and income in per capita terms. He contends that the relationship between income and sawnwood consumption is directly proportional. Income would play a relatively minor role in wood consumption, as additional income would tend to go towards food, clothing etc. As soon as these elementary needs are met, the effect of income should be more pronounced. Then, industrial wood consumption would increase at a faster rate as a result of increased construction activities, shipping, crating, packaging, etc. As income passes beyond some level, the effect of consumption may decline as income would go towards purchasing services.

On the supply side, the relative ease with which wood is available affects consumption. Wood availability is a function of the area of forest land and the forest growth rate. Gregory (1966) constructs a Wood Availability Index (WAI) as a function of population level and forest area that is used for production of wood. A constant is added to adjust the scale of this function. Canada, where wood availability is maximum is given an index of 100. Based on that, WAI of the United States is 80, and that of India is 3. To understand the meaning of WAI fully, one must remember that it considers the area of forest land that is used productively for wood. The low figure for India, therefore, perhaps suggests that the country is poor in the "use of forests" rather than in the richness of forest area.

Gregory (1966) found that the rural-urban ratio did not have any explanatory power, and therefore dropped it from the model. Based on the results of his estimation, using data from a cross-section of 53 countries, including developed and developing countries, he concluded that per capita income is a very good proxy for most of the factors that tend to influence industrial wood consumption on the demand side. The results indicate that per capita wood consumption increases with income but after a threshold the aggregate consumption declines. He explains the decline by the fact that at higher income level people substitute bricks, glass and aluminum for wood. WAI was also significant, suggesting that as wood availability increases, costs of production generally decline resulting in an outward shift in the supply function, and assuming that the demand curve is unchanged, a shift along the demand curve to a higher level of consumption is observed.

Gregory claims that in many studies, it is assumed that increases in income would result in proportional increases in wood consumption. This is an implicit assumption that income elasticity of wood consumption is unity. This assumption has little basis in reality. Countries with low incomes and a shortage of available timber, have high consumption elasticities with respect to income. He estimates from his model that the income elasticities for low income countries at the following levels of per capita income are

Income $ 500 -- 1.22
Income $1000 -- 0.74
Income $1500 -- 0.29

Another common assumption is that when a nation increases its per capita income from, say 300 dollars to 500 dollars, it will change its wood using pattern from the existing one to one identical to that of a nation which currently has a per capita income of 500 dollars. But due to differences between consumption habits among nations, this assumption may not always hold.

Gregory explains that there are many other factors that play an important role in wood consumption but they can not be identified and measured. One way of permitting these factors to exert an influence while still using the important specific relations such as income to wood consumption, is to make direct estimates of the change in consumption that may occur. This implies that each country is moving on its own curve of wood consumption, but with respect to income etc. the curves are all members of the same curve family, and that for a given change in income etc. wood consumption will change according to the results given by the equation (Gregory, 1966). A drawback of this method is that a cross sectional analysis is not made of the effects of changing incomes etc. However, Gregory argues that this method is preferable to a demand estimation attempt. He suggests that in developing countries, this direct method using population and income data can be used to estimate the level of "development" of forest areas that will be required if industrial wood consumption is to be at a necessary level, which is always a crucial question.

Buongiorno (1977) researched on forecasting of forest product requirements for the FAO. The idea behind the FAO models is that the essential driving force causing the per capita growth of consumption is the growth of income. These studies have generally used cross-sectional data to estimate consumption as a function of income. However, to overcome the drawback of forecasting using cross sectional models, Buongiorno accepts current consumption as a proxy variable for all past and present economic, social and ecological forces bearing upon the forest economy. He forecasts future consumption as a function of current consumption and the change in income. So essentially, he also accepts the idea that growth in income is the main driving force in the growth in consumption of wood. In his estimates, he finds that in developed countries, current consumption has the most explanatory power in forecasting future consumption, while in case of developing countries, future income has the most influence. He also finds that the income elasticity of the derived demand for wood due to demand for wood products is markedly higher in developing countries than in developed countries, a finding that corroborates the findings of Gregory (1966).

Buongiorno and Grosenik (1977) estimated the per capita rate of growth of consumption of wood as a function of rate of growth of per capita income and level of per capita consumption. They also find that the income elasticity decreased as consumption increased. For the average consumption level for developing countries in general, they estimated the income elasticity to be 1.6.

Kumar (1994) explains that the most commonly used model specification for estimation of consumption of industrial wood, using time series data considers per capita income, population, wood availability index and a trend parameter to account for factors such as preferences as independent variables. In almost every case, the coefficient of the wood availability index is positive, which is further corroborated by the fact that wood exporting countries consume about twice the amount of wood per capita than importing countries with a similar Gross Domestic Product. Kumar also reports that per capita income is a very good proxy variable for most of the factors that tend to influence industrial wood consumption. In projecting demand for industrial wood on a national basis, Kumar uses a number of different functional forms and population and per capita Gross Domestic Product as explanatory variables. His estimates exhibit large variations depending on the model specifications. We shall look at Kumar's model specifications in detail in the next chapter.

Production of Industrial Wood

In West Bengal, the current production of industrial wood from the northern part of the state consists of both artificial conifers produced in the hill slopes and Sal wood from natural forests in the foothills. About 40,000 cu.m. of wood is available from these forests (World Bank, 1992). The Forest Development Corporation, which is a public sector enterprise, operates three saw mills in this region, in addition to three private mills. The produce from the government forests which account for about 25% of the total industrial wood production of the state, is handled by the

Forest Department and the Forest Development Corporation. Much of the sawn timber goes to these saw mills before they are auctioned by the government. The plywood species are sold to local manufacturing units while the matchwood is sold to the Western India Match Company in Calcutta.

The southwest part of the state, where the Forest Department has invested heavily in implementing Farm Forestry and community management of public forests, annually supplies about 50,000 tons of small timber and fuelwood combined, from Farm Forestry operations alone, besides another 35,000 tons from public forests (World Bank, 1992). The Wood Balance study estimates that these figures will increase drastically to 300,000 tons from Farm Forestry and 100,000 tons from public forests by 1995. The Wood Balance Study also shows a marginal increase in estimated production from 1.18 million cu.m. in 1984 to 1.3 million cu.m. in 1990 to 1.4 million cu.m. in the year 2000, with the increased production coming out of private lands while the public forests produce an estimated unchanged 300,000 cu.m. for all three years.

The expectation of the Forest Department that output from Farm Forestry operations will increase about six fold in about a decade is certainly optimistic. Therefore, success of the Farm Forestry program is crucial and merits further investigation. The next section explains the factors that support or hinder adoption and continuance of Farm Forestry operations based on experiences from India and other developing countries.

Farm Forestry

Farm Forestry, as a component of the Social Forestry Program was introduced in West Bengal, as in most other states in India, in the 1970s. The initial expectation of the government was that farmers would grow trees on their own lands to meet their household wood needs, as was prescribed by the National Commission on Agriculture, 1976. Farm Forestry was not intended to produce wood for commercial sale. However, the initial success and the following disenchantment of the farmers who had adopted Farm Forestry, were entirely guided by the monetary profits generated from commercial sale of the Farm Forestry output (Saxena, 1994b).

According to Saxena (1992), the reasons for failure of Farm Forestry were as follows:

(i) Production problems: dense plantings of over 4000 trees per hectare led to poor quality produce only fit to be used as fuelwood for which there was little market demand,

(ii) For those who produced better quality products, restrictions on transport, and lack of access to markets forced the growers to sell to middlemen whose margins were large leading to a high price differential between what producers got and consumers paid,

(iii) Rapid increase in demand led to poor quality of seedlings planted, resulting in poor quality of output,

(iv) The hybrid of Eucalyptus used in India had undergone genetic deterioration over the years. The productivity of this hybrid was low, which led to poor yield,

(v) Intensive weeding and soil working required to produce quality output was neglected by farmers.

Saxena (1992) suggests possible remedies:

(i) Abolish restrictions on cutting, transporting and selling trees,

(ii) Initiate schemes to link farmers with industries to open up competitive markets,

(iii) Provide better extension so that growers can produce thicker logs which command a higher price,

(iv) Identify short rotation, high value species other than Eucalyptus by conducting genetic research and offer them to tree growers.

Learning from the recent experience, the National Forest Policy of 1988 called for a complete reversal of policy. It prescribed Farm Forestry for production of industrial wood for commercial sale, recognizing that some fuelwood, generated as a by-product, would somewhat ease the fuelwood scarcity as well (Ministry of Environment and Forests, 1988).

The 1988 policy went one step further to say that forest based industries should raise their requirement through establishing direct relationship between the factory and the individual whereby individuals will grow the raw material on their marginal land, under Farm Forestry, for the industry. The policy fully debars the corporate sector from any use of forest lands for growing its required raw material. This aims to act as a policy thrust towards opening up of markets for Farm Forestry output, and thereby act as an incentive for adoption. The forest industries provide strong arguments against this policy prescription. Verma (no date) argues that individual holdings are small and it is not possible to implement large projects in such fragmented land holdings. The growing stock is fully at the mercy of the land owner, who may sell it prematurely to a third party without caring to liquidate the debt to the bank.

Efficiency in the production of paper and packaging material etc. is crucial for the success of the economic development policies of the nation. Such efficiency calls for investments in technological advancement in the industrial production processes, which the industries are unable to make due to uncertainty and shortage in procurement of raw material. Timely availability of quality raw material is crucial for efficiency. The industry's viewpoint is that turning over some marginal lands to them for wood production would serve the dual purpose of efficient production of forest based industrial goods, as well as afforestation and the related ecological, and soil and water conservation benefits (Piare Lal, 1993). However, this is contrary to the National Forest Policy prescription. An acceptable implementation scheme for the policy prescription has not yet been found.

It is apparent from the excess demand for industrial wood as established in the Wood Balance Study that public forests alone will be unable to produce enough for the growing raw material requirements of the forest based industries. Therefore, the success of Farm Forestry is crucial. Anderson (1987) outlines the advantages of Farm Forestry operations in producing industrial wood:

(i) participation of the large number of rural households in tree farming would lead to higher planting rates than is possible for the forest departments to implement,

(ii) wage labor and cost of fencing and protection, would be greatly reduced because Farm Forestry is not labor intensive, and most of the labor is provided by family members,

(iii) farmers would be able to satisfy at least part of their fuelwood needs from their own plantations thereby freeing up time for other income generating activities,

(iv) a large enough participation could lead to reduction of soil erosion and soil moisture retention which could have positive effects on crop yields, and

(v) generally the yield of Farm Forestry plantations is higher than natural forests and much wood can be produced in a relatively small area.

However, there are some basic drawbacks on the production side that hinder the success of Farm Forestry:

(i) there is often insufficient protection from livestock, when the trees are small,

(ii) inappropriate species selection by the farmer due to lack of knowledge and experience regarding new tree species, leads to failure,

(iii) for those farmers with degraded lands which have low soil fertility, extra technological inputs are required for success,

(iv) farmers are sometimes unable to plant trees at the right season due to conflicts with crop planting time,

(v) failure to water seedlings after planting due to water shortage, could reduce the survival rate, and

(vi) due to transport and distribution delays, seedlings are often in poor shape when ultimately planted.

It is imperative that technical assistance provided by the Forest Department to the farmers, address these hindrances, and suggest solutions.

Godoy (1992) investigated the behavior of smallholder commercial tree cultivation in developing countries. He explains the factors that induce smallholders to plant and care for trees destined for the market, and the need to focus on removing constraints on the key determinants so as to maximize tree cultivation as a cash crop. He identifies output price, tenure, information, credit, technology, government policies and labor availability as the key determinants of success. He cites evidence that a sustained price increase in the relative price of perennial trees induces farmers to plant trees for commercial ends, even in cases where land tenure is not secure. In other words, a sufficiently high price for the output of a tree product induces a smallholder to plant trees even if he or she is not sure of obtaining the harvest. This is controversial, and Romm (1981) disagrees. Godoy also finds that the availability of low-cost seedlings and information seems to play a dominant role in initial adoption by the farmers. Regarding provision of subsidized seedlings, he argues that farmers can do without subsidies once they learn techniques of plantation management. The reduction or removal of subsidies raises seedling costs, but this does not affect the farmers' planting decision significantly because seedling costs are a small share of the total investment needed. Also, the removal of subsidies raises the price of seedlings and lures private investment to establish nurseries adjacent to the farms. The influx of private investors puts downward pressure on prices because supplies increase and costs decrease due to lower transportation costs arising from decentralized nurseries and greater efficiency of private nurseries. Saxena (1992) corroborates this argument and concludes that the success or failure of Farm Forestry in India has been totally unrelated to the incentive structure. The main incentive has been subsidized or free seedlings. He also found that the seedling cost is insignificant compared to total cost of the operation. Bahuguna (1994) provides figures to corroborate the argument. Saxena asserts that the reason for this subsidy was to satisfy the government's own targets which could not be met if seedlings had a price and only serious tree growers picked up seedlings.

Commercial tree cultivation meshes well with both high and low population densities, with intensive and extensive forms of cultivation (Arnold, 1988). The advantages are that smallholders can harvest and maintain trees by investing small amounts of time. Also, since they can neglect trees and harvest them when propitious conditions arise, trees allow farmers to pursue off-farm employment.

Rawat (1989) also investigated the role of private farms in producing fuelwood and pulpwood in India. He formulates a production function, V = f(t), where V is the yield per hectare if harvested at age t, and assumes a constant cost, K per hectare, incurred initially and at the time of regeneration, and no maintenance cost. He further assumes that the producer is a price taker and that the price obtained is independent of the length of rotation. In his simple formulation of the problem, the only decision for the farmer is the determination of the cycle of rotation, t. He estimates the cycle for an Eucalyptus plantation with a density of 1000 trees per hectare, for various arbitrary values of price (p), discount rate (i) and cost (K). For p varying between Rupees 100-250 per ton, i varying between 5%-10% and K varying between Rupees 1500-2500 per hectare, the cycle of rotation is estimated to vary between 6-8 years. Comparative statics show that the cycle of rotation is inversely related to price and discount rate and positively related to cost.

From the above discussion, it is apparent that in the adoption of Farm Forestry on a large scale, as envisaged by the West Bengal Forest Department, careful attention must be paid to a number of technical and economic factors. Whereas there has been much emphasis on provision of technical support to the farmers by the Forest Department, the equally important economic parameters have not been dealt with. This is perhaps due to the repeated subordination of the economic aspects in the National Forest Policy (Ministry of Environment and Forests, 1988). However, a number of economic aspects will have bearings on the large scale adoption of Farm Forestry operations that have been envisaged. These will be analyzed later.

Livestock and Fodder

The World Bank (1992) reports that two thirds of the existing public forest lands of West Bengal are under heavy uncontrolled grazing by 30 million livestock distributed among more than a third of the households of the state (Committee on Fodder and Grasses, 1989). Although it is against the law, the Forest Department could not enforce the grazing ban, except in selected protected forests. In some public forests, the Forest Department had a policy of allowing a limited number of livestock to graze after collecting a grazing fee (Poffenberger and Sarin, 1990). The grazing fee was so nominal that even for the poor people in the surrounding villages, it did not affect their decision as to the number of livestock that they should maintain. Over time, it became uneconomical for the Forest Department to collect the nominal grazing fee and then enforce the grazing restriction.

Ultimately, collection of the grazing fee stopped (World Bank, 1992).

Part of the reason for the lack of enforcement is the unavailability of alternate grazing lands. Many previously monocropped areas which are being double-cropped are no longer available as pasture for part of the year (World Bank, 1992). The common property village lands have traditionally been free access grazing areas. However, most of the common property areas in and around villages have been privatized primarily in two ways. First, the more fertile areas have been converted to agricultural land. Second, the remaining areas have been distributed by the government to landless people under various equity and rural development programs (World Bank, 1992). These areas have largely been converted to tree crop plantations under the social forestry program. The choice of tree species has been restricted to Eucalyptus, while the spacing is usually very dense. As a result of such dense monoculture, the floor of the plantations is bereft of any vegetation which could potentially provide fodder (Marballi, 1986).

With little or no land designated for pasture, lack of fodder in private plantation lands, and the limited and seasonal supply of agricultural residues for fodder, the cattle have no other option but to intrude into the public forest lands for grazing. The high livestock density leads to heavy grazing in forest lands which damages existing trees and prevents regeneration by removing saplings, and finally exposes the land to increased erosion. Excessive grazing has been a significant factor in the degradation of forest lands and the resultant deforestation.

There are two distinct types of cattle among the 15.9 million heads of cattle in the state. The local cattle population or what is known as unimproved cattle, and the improved cattle whose lineage is a mixture of Holstein or Jersey breeds and the local unimproved cattle (World Bank, 1992). The unimproved cattle produce very limited quantities of milk. They are mainly kept for their dung, which is used as fertilizer and also to make dung cakes for fuel. Due to the low value of their produce, the unimproved cattle are not valued much either. They are allowed to roam around the village without any restrictions, and are not provided with any fodder over what they can acquire by grazing all day.

The improved varieties of cattle are priced for their high milk production and are much looked after by the owner. They are kept in stalls and are rarely allowed to graze freely. The owners collect fodder by cutting grasses from the forest land and stall feed the cattle. To supplement their diet, commercially produced feed is also provided to these cattle. These cross bred cattle provide close to 3,000 liters of milk annually (Committee on Fodder and Grasses, 1989). The current price of milk averages Rupees 5 per liter. Therefore the total value of milk produced by a single improved cow can be up to Rupees 15,000 (US$ 500) annually. Given the per capita income of Rupees 3000 (US$ 100), this is a major source of income and is comparable to an average revenue accruing to a farmer from cultivation of one hectare of mediocre crop land. Ownership of a few improved cows is considered to be a sign of wealth among the rural community. Although there are no data or even estimates on the number of improved cattle compared to the number of unimproved ones, it can be safely said that the ratio will be very low.

Free access to grazing in public forests has led to the increase in the population of unproductive, unimproved cattle. The degradation of forests due to grazing is entirely due to the large population of unimproved cattle who are left to graze freely. The marginal private cost to the owner for maintaining additional numbers of unimproved cattle is close to zero. The unit returns from these cattle, in the form of dung and the occasional supply of milk that they provide, is also low. However, the marginal returns certainly outweigh the marginal costs, even for a large herd size, which justifies the maintenance of large numbers of unimproved cattle. The significant social cost due to the negative externality in the form of forest degradation is, however, unaccounted for. If the owners could have been made to bear at least a part of the social cost of grazing of these unimproved cattle, it would have been uneconomical for them to keep unimproved cattle at all (Singh, 1994).

With increasing degradation of forest lands, the goat population has increased significantly over the last few decades. In West Bengal, the goat population went up from 500,000 in 1961 to 11 million in 1982, a twenty one fold increase in twenty years (Report on Fodder and Grasses, 1987). Goats have the capacity to survive on marginal fodder. Therefore, highly degraded forest lands which cannot sustain populations of unimproved cattle any longer can still provide enough nutrients for goats. Goats provide a fair amount of milk and can also be slaughtered for meat. Goats, however, are extremely destructive to the environment as they consume almost all organic matter.

It is, therefore, apparent that the livestock situation in West Bengal has gone out of hand. The World Bank (1993) conveys the same picture: large part of India's livestock population grazes in forests which causes serious damage to regeneration and young plantations but there are no realistic management alternatives yet. Heavy grazing in the forests damages trees, compacts soil and prevents regeneration. Without policies to curb the population of unimproved cattle, fodder production under the forest management programs that are underway will be unable to meet the requirements, while their contribution towards forest degradation will continue. The success of the various forest management programs will be affected due to encroachment of grazing livestock in forest lands.

The livestock population density is considered to far exceed the carrying capacity in most areas in India (Committee on Fodder and Grasses, 1987). Nationally, India has 13% of the world's livestock population and less than 0.5% of the world's grazing lands (Khoshoo, 1994).

The issue of livestock management is major and piece meal policies will perhaps not make a dent. The carrying capacity of livestock can be increased by investing in fodder crops, which could be justified by increased productivity of livestock. Therefore, to keep the number of livestock within the carrying capacity, measures to increase their productivity by eliminating population of local animals along with improved feeding techniques are required.

Nontimber Forest Products

Nontimber forest products have always been important to the forest communities, particularly to the poor, as a much-valued supplement to their subsistence level of existence and also, in a few cases, for cash earnings. Repetto (1994) claims that on average, as much as 20-25 percent of the annual incomes of rural poor households in India comes directly from common property resources. Also, in the off season smallholders find more employment in harvesting nontimber forest products than in their own farms. During drought years when farming is impossible they can fall back on nontimber forest products as a reserve supply of subsistence products. Micro studies by Malhotra et al. (1989), explained later, have established that the poorer the household, the greater is its dependence on nontimber forest products for subsistence. Timber-oriented forest management practices did not incorporate the value of nontimber forest products to the livelihood of the rural population in forestry programs. However, the forest communities were not affected by it because whereas timber extraction from public forests has always been illegal, there were no restrictions on extraction of nontimber forest products (Khosla et al., 1986). The problem first arose when timber-oriented forest management practices attempted to increase timber productivity by replacing natural forests with dense monoculture plantations. These plantations did not provide any nontimber forest products. Panayotou (1993) asserts that many forests are managed for timber production alone when management for multiple uses such as nontimber forest products, water and soil conservation, biological diversity and a host of other environmental services would generate a higher return in the long run. However, the practice of creating monoculture plantations by replacing natural forests was short-lived (Poffenberger, 1990b). Currently, nontimber forest products constitute an important component of natural forest management.

In the areas under participatory management in West Bengal, the community members are allowed to extract reasonable quantities of nontimber forest products in return for protecting the forest from illegal extraction. Since the availability of nontimber forest products increases in proportion to the overall density and health of the forest, the protection offered by the village community leads to regeneration of degraded forests and therefore increased availability of nontimber forest products which the people can collect. One of the goals of the Participatory Forest Management system is to establish this mutually beneficial cycle (Poffenberger, 1990b).

Chaturvedi (1994), however, warns that the sustainability of forest lands under Participatory Forest Management may be in question due to excessive removals of nontimber forest products. For maintenance of natural forests, only incremental growth of forest products should be extracted. In Participatory Forest Management, however, in addition to selective logging operations, most of the nontimber forest products including leaves are routinely removed. Such removals are detrimental due to ecological interdependencies of forest systems. Floor sweeping for leaf collection, for example, completely removes ground litter and humus from the forest floor, and does not allow the soil to assimilate nutrients. Harvesting in short rotations inherently causes stress on the forest system (Chaturvedi, 1991). During the early stages of growth, trees extract large quantities of nutrients from the soil, compared to mature trees. Therefore, in case of repeated ten year cycles such as in Arabari, on one hand the trees continuously extract enormous amounts of nutrients from the soil; and on the other hand, the removal of all nontimber forest products keeps the forest floor bare, thereby preventing the natural enrichment of the soil. After the first few rotations, it is possible that the forest will show signs of strain, and productivity of the various products will decline (Chaturvedi, 1994).

The benefit stream of nontimber forest products in a Participatory Forest Management system was studied by Malhotra et al. (1989) in the Jamboni Forest Range of West Bengal, where Sal plantations are regenerating under Participatory Forest Management. The study examines both the subsistence and commercial value of nontimber forest products to the community, based on a sample survey covering 42 Forest Protection Committees. Malhotra found that 189 species, including 113 from plants and 76 from animals were used by the local communities. Of the plant species, 27 species were harvested for commercial purposes, 39 species provided for their food needs, and 47 species were used as medicines for themselves and for their livestock. Availability of nontimber forest products varied seasonally as well as with the efficiency of the Forest Protection Committees. It was also found that the availability was maximum in the summer months, May through August, which coincided with the leanest months for the forest community in terms of food stocks and income opportunities. Better managed Forest Protection Committees also led to the increased availability of nontimber forest products.

A subset of eight Forest Protection Committees were used to determine the economic value of nontimber forest products to the households. The value of the total annual collection of a household, (fuelwood was included in the list), came to Rupees 2,815 (US$ 90). On a per hectare basis, the median was Rupees 2,000 (US$ 65). This is significant in comparison to the per capita income of people in West Bengal which was Rupees 2,988 (US$ 130) in 1986-87, and per capita agricultural income was only Rupees 1,813 (US$ 80) in 1985-86 (Hazell, 1990).

Palit (1992) reports a survey of 216 households covering 12 Forest Protection Committees in West Bengal, which found the value of annual nontimber forest products collected per household to be Rupees 2,418 ($78) compared to the mean household annual income of Rupees 6,814 (US$ 200) from occupational income. Over the 10 year cycle of the participatory management program, Palit projects that household income from nontimber forest products (ten year total, discounted at 5% per year) is Rupees 20,852 (US$ 672). He compares it to the promised 25% of the sale proceeds of forest harvest at the end of the ten year cycle, which would yield only Rupees 6,974 (US$ 225) to each household. However, the gap between the two income sources would be reduced if a higher discount rate than 5% per year is assumed.

Forests and Environmental Quality

The State of the Forest Report (Ministry of Environment and Forests, 1989) claims that of the 9.6% of the geographical area of the state under actual forest cover, only 40% is under more than 40% crown density, while 25% is under mangrove. The remaining 35% of the forest is degraded to varying degrees. The Forest Statistics of West Bengal (World Bank, 1992) also indicates that more than 300,000 hectares of the recorded forest area of 1.2 million hectares are totally degraded as scrubland and rooted wastes.

The two most important negative externalities of forest degradation are increased erosion and loss of biodiversity. For a proper understanding of these effects, one has to go outside the political boundaries of states into a larger region.

Deforestation directly reduces the tolerance level for carbondioxide because trees absorb the gas and produce oxygen. The reduction of wetlands leaves the water bodies with excessive amounts of urban waste, fertilizer, pesticide, oil spills and industrial chemicals, and results in water pollution. Forests conserve the top soil against wind and water erosion. Swaminathan (1982) asserts that while it takes anywhere between 100 and 400 years for one centimeter of top soil to be formed in nature, all this soil can be lost in just one year because of erosion. In India, the loss of topsoil is estimated to have doubled in the last fifteen years (West Bengal Forest Department, 1989). Loss of topsoil has serious implications for agricultural productivity. In fact, much of the fallow land in India is due to excessive erosion. Erosion also leads to sedimentation of river beds. The silt also settles on the floors of reservoirs, which affects the productivity of hydropower and irrigation projects. In most of the large multi purpose irrigation projects, siltation has been much higher than predicted at the project formation stage (Ministry of Agriculture, 1992). Pollution is another example of externalities originating from forest degradation and affecting agriculture, and other factors of production such as water (Panayotou, 1993).

The above examples constitute misuse of unpriced or open access resources and negative externalities to sectors and individuals who may or may not be party to the externality generation activities. This is so because the environment serves both as the recipient of the residuals of economic activity and the medium that transmits offsite effects to second and third parties.

India has traditionally been rich in its diversity of flora and fauna (Panwar, 1994). Along with the degradation of forests, it is apparent that the biotic diversity is reduced. Whereas there are no systematic studies to measure the effect of forest degradation on biodiversity, the disappearance of some species of plants, animals and birds has been observed, while the population of many others has been steadily on the decline. Diversity of species and environments is essential to long-term productivity and sustainability of economic development. Its preservation is a form of investment for the future or insurance against future uncertainties. Its diminution constitutes environmental degradation even if an equally productive asset has replaced it as a factor of production or a source of consumption (Panayotou, 1993). Some of these biotic resources in turn are used to save human lives. Myers (1983) claims that 50 percent of modern medicines come from the natural world, while an estimated 1400 forest species may have anti-cancer properties (Myers, 1983).

Sandler (1993) points out that one fourth of all prescription drugs sold in the United States are derived from tropical plants.

The World Bank Forest Policy Paper (World Bank, 1991) states that both the government and the private sector tend to overlook the environmental benefits derived from intact forests and the environmental costs of improper forest harvest and management activities. Because these environmental aspects are not valued in the market, they are easily ignored. A society may place a high value on the environmental services provided by the forests, but forests may be undervalued by the market, the private sector, or governments if the services do not generate a monetary return.

Based on the information collected in this chapter, an analysis of the dynamics of fuelwood and industrial wood consumption in West Bengal, as performed in this study, is presented in the following chapters.

CHAPTER III

SOCIOECONOMIC AND INSTITUTIONAL ISSUES IN FOREST MANAGEMENT PROGRAMS

The success of the forestry programs being developed on the basis of the National Forest Policy (1988) is dependent on the successful adoption of management practices by forest communities. This chapter will explore the difficulties in reconciling the project goals with the interests of the community members, which are guided by traditional behavioral accords as well as their perception of costs, benefits, and risks of involvement.

A comparison of the institutional structure required to implement the new Participatory Forest Management programs with the traditionally existing one, reveals the following differences. The Forest Department had the sole authority in making planting, maintenance, and harvesting decisions in public forests. They also held the power to allow or restrict forest communities from extracting forest products such as fuelwood and fodder, without consulting the users. The notion was that the public forests belonged to the government which automatically had complete rights to all benefits from the forests. The allowance of forest communities to extract products was considered a privilege, for which a fee could be charged.

The current policy attempts to change this institutional structure, the reasons for which are explained later. As is apparent from the organizational setup of the Participatory Management system in West Bengal (see Appendix III), planting decisions are to be jointly taken by the community and the government, management decisions are mostly in the hands of the forest communities, although within the bounds laid out by the Forest Department, while harvesting decisions are to be taken jointly. Decisions to extract products such as fuelwood and fodder from public forests are to lie in the hands of the community. Moreover, the community is remunerated for its services as a partner in forest management by a share of the revenue and assured employment at the time of harvest.

The interactions of the forest community and the government are in the areas of technical assistance to forest communities at all stages of management by trained foresters, assistance to community members in forming Forest Protection Committees, including drawing up of a constitution, and in the constructing of community-specific working plans as well as in deciding conflict resolution measures, including punishment for violating the jointly decided rules.

The decision to change the basic structure of forest management has serious implications that need attention for the successful implementation of the policy. Let me now turn to an analysis of these issues in the Participatory Forest Management and Social Forestry programs.

Participatory Forest Management

Participatory Forest Management, as is being practiced in West Bengal, involves joint management of government owned forests with local community members grouped into Forest Protection Committees. The government provides the required funds and technical assistance in planning and maintenance, and obtains 75% of timber harvests at the end of each rotation. The community members provide protection and have the right to collect fuelwood, nontimber forest products, and fodder, at all times. During harvest, they are hired as laborers, and are also given 25% of the revenue. The detailed design of the Participatory Management system of West Bengal is provided in Appendix III.

Social Forestry

The Social Forestry program has two components. First, it supports tree farming on private lands, which is known as Farm Forestry. In Farm Forestry, the Forest Department provides the tree farmers with subsidized seedlings, and technical advice on raising plantations. Second, it supports Strip Plantations, which involve tree growing in unforested common property lands. The Forest Department provides seedlings and technical assistance, and the community members are allowed to obtain fuelwood and nontimber forest products at all times, as well as obtain the entire revenue from the sale of wood at the time of harvest.

In the forestry sector, the equity/efficiency issue often arises, though it is only rarely perceived as such. In this case, there is a public forest and a village woodlot management component and a Farm Forestry component, which in many ways amount to an equity-oriented part and an efficiency-oriented part respectively. It is usually stipulated in some fashion that the produce of the woodlot be evenly divided between village households, while the seedlings and extension advice for Farm Forestry are available to whoever wants them. However, characteristically, the Farm Forestry side is considered a success with farmers taking far more seedlings than targeted, while the woodlot side fails because of the insecurity of tenure, difficulty in obtaining agreement on what to plant and how to protect, and all too often the benefits go to the local elites that dominate village life.

For the purpose of this analysis, we will look at Participatory Forest Management and Strip plantations together because they are both subsistence oriented programs, with a small cash income component, practiced in publicly owned lands. We will call them community forestry programs. We will also look at Farm Forestry, which is a market driven production system, practiced in private lands.

Community Forestry Programs

Chopra et al. (1990) define the constituents of common property resources as

(i) That part of the land which although classified as privately owned allows partial common access,

(ii) Cultivable wastes and fallows,

(iii) Common grazing lands, and

(iv) Protected and unclassed forests.

According to this definition, public forests on government lands under Participatory Forest Management are common property resources.

Reasons for Policy Change

Gadgil (1990) provides a brief history of how rural communities were introduced into the community management scheme of India's public forests. Until the 1970s, although the government continued to assert authority over the remaining commons at the expense of local communities, their ability to enforce restrictions on access and use eroded under the pressure of local demands. There was considerable conflict and tension between field staff and villagers. The foresters had a paramilitary orientation in dealing with rural people and carrying out their custodial activities (Roy, 1991). As the resource base shrank and population expanded, forest officials found themselves increasingly cast as guards and police, fighting against encroachment by local people seeking access to resources they badly needed and had traditionally used. In the villages, resentment against the government's much more favorable treatment of large scale industrial interests in access to common property resources often ran high. With weakened authority over the commons, village councils were less able to limit exploitation. For such reasons, common property resources that had once been managed more or less sustainably through local traditions and community authorities increasingly became open to unregulated exploitation by all. Invariably open access to these resources tended toward a situation described in Garrett Hardin's famous "tragedy of the commons," where no one had reason to restrict their own use knowing that others were free to exploit the common resources without limit.

As Bannerjee (1989) explains, like many political and social movements, the concern for forest loss emerged out of a crisis. The crises are twofold; first, the crisis of eroding resources and its larger socio-ecological implications. Second, the crisis of confidence, and the ever-widening gap between the professional forester and the people. The forest departments were established over a hundred years ago during the colonial period. In those days population pressure on the forests was light. Consequently, all the silvicultural regimes, management practices and priorities were developed in a situation of plenty. Today the situation has changed dramatically and the traditional forestry attitudes and concepts have much less relevance.

Under these circumstances, community involvement in forest management was experimented with to halt the exploitation. While commercial or industrial forestry programs are age-old systems, community forestry programs are a recent invention. Under a conventional type of industrial forestry program, business corporations or government agencies hire laborers to establish plantations of large tracts of land that the agencies control; the wood is harvested for use in industry or construction, while fuelwood and nontimber forest products are often collected by the rural people. The alternative approach, community forestry, is to induce a large number of small farmers to plant fuelwood trees systematically for their own needs on available common property land, and assume the responsibility of protecting public forests from exploitation. Social community programs demand high local participation, and rise or fall depending on whether or not the community members engage in the program.

In community forestry, self-managing groups acting as economic agents can achieve for their members significant economies of scale in several respects:

(i) primarily with respect to labor required for tree planting and cultivating,

(ii) in labor for harvesting and transporting,

(iii) groups usually can bargain more effectively than individuals when selling the harvest or when negotiating with authorities, and

(iv) also in protecting forests from theft, fire, etc.

Community Management Experiences

The World Bank (1993) reports that the Forest Protection Committees in West Bengal are a famous example of successful joint forest management. Starting in 1972 the Forest Department convinced local populations in Arabari in Midnapore district to protect public Sal coppice forests through the formation of Forest Protection Committees in return for free usufruct of all nontimber forest products, first preference for forest employment, and a promise of a 25% share in the net cash benefits from sale of wood. Initial success led to a gradual spread to neighboring areas and increased support from the Forest Department. The Forest Protection Committee model proved effective in improving the relationship between forestry staff and local people and in increasing Sal forest regeneration and economic returns. Although the government has to share the benefits with the community members it now receives considerably higher revenues from regenerated forests than it did when the areas were degraded (World Bank, 1993).

Although the Arabari experiment with public forest management was a success, experiments in a number of developing countries with community managed plantations did not do well. Many planners and foresters assumed that massive planting of fuelwood could best be induced on communal lands by involving large numbers of people in planting, tree protection, and in sharing the benefits. The apparently plausible social assumptions were that communities would influence their members to plant, would mobilize labor and promote self help, and would collectively protect the young plantations. It was also optimistically assumed that they could ensure the wide distribution of benefits among the small farmers who usually make up the majority of the communities. These woodlots have worked successfully only in authoritative government controlled plantations in Korea and China (World Bank, 1991). Between 1977-1986, about 50 percent of World Bank's lending to forestry went to 27 projects which included some form of community forestry. The Bank's lending for social forestry tripled in the 1987-89 period compared to the full prior decade. Major resources also came from bilateral donors such as USAID, CIDA, ODA, SIDA and others. Yet in most cases, according to evaluation reports, the actual plantings accomplished under the "community" model fell below targets and did not justify the investments made. In many areas, on account of the little interest shown by community members, the model was modified to give considerable management authority over village woodlots to the village Panchayats. Of course, this was an administrative substitute for the user/produce responsibility, wholly missing the crux of the social forestry strategy, and the subsequent assessments in 1988 and 1989 confirmed the earlier conclusion (World Bank, 1989).

Arnold and Stewart (1991) found that in community management programs in India sponsored by SIDA, most villagers did not know how the produce from the village woodlots would be distributed; most of the people did not expect any share from the final output and looked upon such woodlots as another category of reserved forests. Gill (1986) found that village communities have proved most reluctant to manage trees planted as a corporate resource.

In West Africa the community system was also found ill-suited to serve as a vehicle for reforestation (Thomson, 1980). In several other Asian countries, its adequacy was questioned as well (Noronha, 1980).

Alienation of the rural community has been observed in West Bengal too. Palit (1994) finds that very often the forest communities have little opportunity to participate in decision making processes. Under the present system, Beat Officers prepare the microplans under the supervision of Range Officers. The abilities of Beat Officers to design good microplans vary resulting in inconsistencies and overall low quality of microplans. However, input from the village communities as to their specific needs is not sought or used, although the design of the program emphasizes joint decision making. Such alienation has resulted in lack of awareness among the community members of the manifold advantages in protecting the forests (West Bengal Forest Department, 1989). Ostrom (1994) also stresses the importance of operational collective choice arrangements in decision making. On a broader level, she calls for a system where the rights of the individuals to devise their own institutions are not challenged by government authorities. However, due to the lack of legal status of Forest Protection Committees in West Bengal, the members feel a lack of authority in discharging their duties (West Bengal Forest Department, 1989).

Social Organizations

FAO (Cernea, 1989) has defined social forestry as including any situation which intimately involves local people in a forestry situation. This is an overly broad and imprecise definition, of little practical help when it comes to saying which people, under what structural arrangements and so on. Operationally, it is not only a challenge but an absolute necessity to disaggregate the broad term "people" and to identify precisely "who" and "how": what units of social organization can and will manage the forests or plantations and which social unit and definable groups can act as sustaining and durable social structures for long term production activities. Such social organizations can be either

(i) Naturally existing social units, such as the individual family household, such as in Farm Forestry,

(ii) Groups organized purposively to plant, protect and manage forests or plantations, such as Forest Protection Committees, or

(iii) Groups established for purposes other than forestry, but which are able to undertake forestry related activities as well, such as village panchayats.

The Forest Protection Committees in West Bengal are formed by including one member from each household in the community, subject to their willingness to participate. However, establishing a functional social group means much more than simply lumping individuals together into an artificial entity given the label "group" on paper, as is the case with Forest Protection Committees in West Bengal. It implies a process of selection or self-selection of the members' perception of both self-advantage and co-responsibility, and the establishment of an enduring intragroup structure with well-defined functions. This in turn helps mold patterned behavior among members and is the essence of grassroot, purposive institution building.

Further, when forestry programs are designed, it is essential to realize that there are a number of different potential "social actors", but they are not equally fit for carrying out each and all silvicultural approaches to forestry. Such technologies refer to species selection, site selection, nursery development, planting technology and configurations, fertilizing, plantation managing, enclosure or other protection, marketing and so on. The West Bengal Forest Department trains the Forest Protection Committee members in technological matters but, as we shall see later, such extension is difficult to provide under the existing set up.

Participatory strategies in West Bengal aim to engage the rural users of fuelwood into organized activities for producing and managing forests, to shift from simple foraging and gathering fuelwood in naturally grown forests to cultivating trees for fuelwood. Trees and forests are to be systematically produced. Therefore, the social innovations fostered through this policy are two pronged: they attempt to involve large groups of people in the conservation and better management of existing natural forests, and, since this would not be enough, to stimulate the widespread adoption of a new productive activity: the systematic planting of trees for fuel, as opposed to the age old wood gathering in natural forests.

However, the situation in West Bengal is similar to Cernea's (1989) general observation that many forestry programs intended genuinely to be participatory are formulated in fuzzy terms, are not designed around well identified social actors, and neglect to ensure clear benefit distribution arrangements and incentives. The key difficulty, as Cernea points out, is a social and institutional one: precise identification of who the people are and how they are organized for development action, and how to generate and sustain the involvement of social actors, the people who are to give life to the project.

Cernea (1989) explains the reasons why communities as population clusters should not be treated as ready to use units of social organization or economic agents, as is being done in West Bengal:

(i) Communities and villages are geographical residential units--physical vicinity alone can not engender the type of long-term collaborative action required for a woodlot enterprise.

(ii) The interests of community subgroups often differ such that collective unified action required by long-term afforestation programs is generally not possible. Usually communities are heterogenous population clusters, stratified and split in factions and subgroups with fragmented socioeconomic interests. What is advantageous for one group is not necessarily advantageous for another.

(iii) Community land is limited and there is reluctance to make it available for tree planting. The poorest households have a vested interest in not allowing the commons, which to them are a continuous although meager source of products, to become closed, unaccessible woodlots. As Jodha's (Jodha, 1990) research has demonstrated, the poorer households are more dependent on the products from the commons.

(iv) Uncertain tenure status of common lands engenders uncertainty about the tenure of the planted trees; it is also unclear which social body has jurisdiction over the allocation of common lands.

(v) Specified intragroup rules and guarantees for distribution commensurate with their contributions are lacking, and exclusionary rules against noncontributors are absent as well. This is reflected in the fact that the area of forest land and the number of participating members in the corresponding Forest Protection Committees do not bear any relation to each other. The regenerative capacity of the forest land is not related to the size of the community either. As a result, the magnitude of benefits accruing to the participating community varies. The West Bengal Forest Department (1989) realizes that there should be an optimal area of forest to be protected by each Forest Protection Committee to ensure a certain level of minimum returns of forest produce per member. But in reality such is not the case.

At a general level, social forestry strategies should be developed with the following characteristics:

(i) must be conceived starting with the definition of the adequate unit of social organization capable of translating strategies into practice, and of motivating each other to plant and maintain and protect the trees,

(ii) must ensure a match between the silvicultural technologies they promote and the social groups they aim to involve and their specific subsistence needs,

(iii) must benefit the poorer strata of the community, and,

(iv) must carry out a certain amount of social engineering such as group formation and maintenance, establishing incentives and penalties, setting up authority arrangements and communication channels, benefit distribution, and so on.

The success of these programs clearly requires institution building to change people's behavior towards trees and take appropriate collective action. Ostrom (1994) states that it is the match of institutions to the physical, biological, and cultural environments in which they are located that will enable institutions to survive. Fortman (1988) highlights the key issues behind successful community management. She says that financial investments alone can not make the program a success. It needs collective adoption. Success has the highest chance when people belong to organized groups, when they are informed and consciously perceive that it is in their best interests to act purposively in a coordinated manner, and when the group has developed leadership structures and internal norms and procedures capable of organizing and managing its members and for overcoming conflicts and deviant behavior. The projects must start with the establishment of such a viable group.

However, heterogeneity among individuals in a group can lead to dissatisfaction for some members. For example, those households with higher opportunity costs for labor, due to small family composition or off farm employment, will benefit more from reduced fuelwood collection time due to increased availability in nearby forests. But households with surplus labor may be less inclined to participate. To be able to deal with such heterogeneities, the issues of social engineering such as group formation, leadership, participation in decision making, intra group structures, incentives, penalties, communication, and benefit distribution, must be managed with with the same scrupulous attention as is given to the technical or financial elements of the strategy. Unfortunately, the Forest Protection Committees do not reflect considerations of these social factors which must be woven into the very fabric of the program from the outset.

Social forestry modeled on groups has to address certain complexities resulting from the actor being a group of farmers, rather than an individual farm family/household: namely issues of joint dependence over a piece of land and, sometimes, group tenure over trees; issues of group management, labor allocation, and monitoring; and probably the most sensitive, the issue of benefit distribution. Therefore organizing and promoting groups as units of social organization for social forestry programs means designing clear social arrangements for tenure, management and distribution, arrangements that are known, implemented and adhered to consensually.

In eastern Africa, where customary systems of collective control of the land predominate, with individual households having rights of cultivation and use on an area of land, systems have long been in existence that distinguish security of access to trees from security of access to land (Warner, 1993).

However, such is not the case in West Bengal. Many duties, rights and obligations are not clearly defined as yet. They include the duration of the right to obtain benefits from common property lands, whether it is perpetual or temporary. Regarding the removal of nontimber forest products, including fuelwood, the guideline is to restrict the aggregate removals below sustainable levels but the threshold above which removals would be unsustainable is not known. There are no fixed rules for distributing the noncash benefits from public forests equitably among the participating community.

Also, the benefits foregone by the community, especially during the initial stages, and their effort in protecting and managing the forest, do not bear any relation to the shared benefits they receive (Arora and Khare, 1994). The long production cycle for trees weakens the confidence of those planting today in the belief that they will get wood eight or more years later, and it favors the lingering suspicion that the authorities will appropriate the wood anyway. This has been observed in West Bengal. The lack of confidence in, and uncertainty about, the scheme in terms of the participants' share in the yield have led to a lack of motivation among community members and their half-hearted participation (West Bengal Forest Department, 1989).

Ostrom (1994) emphasizes the need for a monitoring system to detect violations and a rapid, low cost conflict resolution mechanism. Arora and Khare (1994) assert that due to the lack of a legal status of the Forest Protection Committees and the backlog in the judicial system, the entire project can fall apart if matters are taken to court and the program is halted till the court comes up with a decision, which may take a relatively long time. This problem is of greatest concern when the offenders do not belong to the forest community at all. In many cases, people from distant areas come in an organized way to pilfer from forest lands. The Forest Protection Committee members, although untrained in law enforcement, clash with them resulting in violence. These incidents dampen the spirits of the community, cause physical injuries and create a feeling of insecurity among the community members due to their absence of a legal status (Palit, 1989). In 1986, at the time of the first harvest in the Arabari pilot project, a group of people from an adjoining area claimed that they had assisted in forest protection in the Arabari range and demanded a share of the revenue. They took this matter to the legal system, due to which the actual payments to the Forest Protection Committee members were delayed by many years (West Bengal Forest Department, 1989).

Although the National Forest Policy (Government of India, 1988) prescribes that "direct economic benefits from public forests must be subordinated to the principal aim of environmental stability and provision of sustenance to all life forms," it does not address the issue of loss in government revenue due to sharing it with the community. The World Bank (1993) observes that in areas of Participatory Forest Management, the government's share of the revenue in spite of sharing it with the community is more than the earlier revenue from degraded forests. Even if that is valid, in the long run the government is free to charge user fees to the community for deriving benefits from government land. The government can impose a tax on forest produce obtained, similar to the tax on agricultural income, or charge a fixed rent on the land to the Forest Protection Committees. Whether these options will be exercised or not are unclear at this time. However, they do need to be clarified early in the program.

Interaction with the Forest Department

The top down form of organizational set up in the Forest Departments, formed for traditional forest management, may not be compatible with the new system where the local community members participate with the forest department as partners in forest management. Community management is clearly a bottom up approach. Secondly, the existing setup, based on functional specialization, is vertically divided in units such as Territorial Forestry, Social Forestry, Soil Conservation, Biosphere, Wildlife, and so on. These functionally specialized units, in any case, do not benefit from the experience in specialized areas, due to frequent transfer of foresters from one unit to another. Further, the integrated management approach, which the 1988 Policy supports, is not consistent with compartmentalized functioning of the Forest Department units in the same geographical area. This would invariably lead to overlaps of functions, which indicates inefficient use of resources.

The World Bank (1992) suggests changes in the institutional structure with a view to closing this gap between the old administrative structure and the new program objectives. They recommend a horizontal integration at the regional level with more decentralized authority, so that each unit is responsible for all functions of a forest area, which is more consistent with the 1988 Policy goals. There is also a need for coordination between the different development agencies of the government such as agriculture, horticulture, irrigation etc. so that all development programs, to a certain extent, are integrated with joint forest management.

However, the basic institutional structure that exists now has been in operation for the last hundred years, while the suggested ones have not been tested at all. Therefore, the burden of tradition, as well as the possible practical difficulties that may not be predicted at the formation stage, is likely to slow down the process of a major institutional change in the Forest Department.

Training

Although the basic objective of forest management has changed from a timber-oriented approach to subsistence-oriented management, the existing forest education and training remain the same as they were before (Palit, 1994). Palit claims that there have been some superficial additions intended to bridge the gap, but the primary program has not changed. As a result, some of the important issues in current forest management are not included in the training programs. For example, successful promotion of Farm Forestry will need training on market research and sale promotion, the status of economically important tree species and their ecological adaptivity and regenerative capacities.

In case of Participatory Forest Management, the lack of proper training has an impact during the design of micro plans. Traditionally, under the top down system, working plans were designed for the long run on a statewide basis. In the case of Participatory Forest Management, a more bottom up system of designing micro plans for every individual scheme, is being followed. These plans take into account the resource availability, investment requirements, the needs of the community, and a scheme for distribution of benefits of forest products among the community, including revenue sharing between the government and the community members, as the case may be. Instead of state wide working plans filtering down to the forests, these micro plans add up to form an aggregate working plan. This important concept, however, does not feature in current training programs (Palit, 1994). Therefore, the foresters who advise the communities in preparing the microplans are not trained themselves. As a result, Palit contends that microplans are often not of a high quality.

Bannerjee (1989) summarizes the above problem. He explains that while the growing and tending of trees is well known to professional foresters, they are handicapped in encouraging popular participation. Their background in terms of expertise, training and tradition has never encouraged community participation. The major problem faced by the professional foresters now is to develop the capacity institutionally to promote and formulate realistic programs to manage forests in a way which is meaningful to the people who live near the forests and suffer the problems of forest loss.

The implementation is largely approached through traditional knowledge of silviculture, and with an imperfect and mundane knowledge of the needs of the forest communities. The concept of people's participation is still obscure, it means merely to provide some employment opportunities to rural people, and to offer some low-priced forest products as fringe benefits. By achieving these, it is thought that popular participation has been ensured.

This lacuna is reflected in the design of forestry programs in West Bengal. For example, although there is widespread agreement among Indian policy makers that the principal means of averting damaging shortages in the future is through planting of additional trees, with the trees established where the fuelwood is needed and with the involvement of the fuelwood users, the subsequent design and implementation of interventions intended to support smallholder tree growing have been developed without much information about why farmers do or do not grow trees. In comparison to the crop and livestock components of agriculture very little is known about existing tree management practices, about farmers' perception of the value of trees and of different tree outputs in meeting their needs and production objectives, and about the constraints farmers face that limit their potential to develop tree resources within and around their farming systems.

Problems During Transition to Participatory Forest Management

At the beginning of the program, the designated forest land is closed to the people. During the first few years, extraction of forest products is stopped or reduced to allow the forest to regenerate to a threshold level. The period of closure depends on the forest type and the state of degradation. During total closure, the section of the rural community that is greatly dependent on the forests for its subsistence, is hardest hit. It consists usually of the poorer members of the community who have little resources to tide them over the closed period when they must purchase the basic necessities. There is no mechanism to assist them (Arora and Khare, 1994). Out of frustration and desperation, these members continue to extract forest resources for subsistence. The Forest Protection Committees are unable to stop them because of their distressed situation. This leads to a breakdown of the forest protection system. This problem has been observed in West Bengal when, due to lack of alternate grazing lands, cattle owners were forced to graze their cattle in protected forests (West Bengal Forest Department, 1989).

It has also been observed in West Bengal that, due to closure of forests during the initial stages of implementation, the households who depend heavily on the forest for subsistence go to adjoining forests for fuelwood and fodder (West Bengal Forest Department, 1989). Forest communities in those adjoining forest lands treat them as intruders and sometimes conflicts arise. When the adjoining forest is also brought under another Participatory forest management system, the problem escalates, and the dependent households are forced to travel to more distant and yet unprotected forests (Sarin, 1994).

Replication of Pilot Projects

The Arabari experiment has been considered so successful in meeting its objectives of forest regeneration and increased availability of subsistence products and timber, that it received worldwide publicity as a success story. Although the "Arabari model" is being replicated all over the state, and beyond, there are a number of reasons why replication of pilot projects may not be as successful. The problem is that all too often the pilot project is overly artificial in the sense of being a laboratory where an experiment may flourish. These artificial conditions will be absent during expansion. For example, the quality of leadership in case of the Arabari project was extremely high because the project was conceived and implemented by a forward-minded forest officer for whom the success of the experiment was a challenge. He could motivate the cadre of field workers that an inspired leader can attract. He could carefully and rigorously monitor the project. There was constant direct communication between the project leader and the Forest Protection Committee members, as well as with higher levels in the administration. Also, as Blair and Olpadwala (1988) point out, pilot projects, in general, encourage participation from below which enhances the potential for success. Replicated projects, on the other hand, face interference due to political interests and the varying role of the Panchayats in terms of initiatives and cooperation. Also, the problem of differences in the ability of the forest staff in establishing rapport with the people and thereby motivating them has been observed in West Bengal (West Bengal Forest Department, 1989).

Another shortcoming of the joint management system from a collective rationality standpoint is that the interests of community members may be different from the national interest because

(i) Externalities lead to a divergence between private incentives to cut or plant trees and the real economic costs and benefits of these actions,

(ii) Insufficient property rights lead to lack of long term interest in conservation, and

(iii) Private discount rate is high due to the urgency of the poor for current needs.

Summing up, the above brings three sets of social variables into the limelight: the complex land tenure system and the processes affecting it; the community as a cluster of nonhomogeneous groups, with differential access to common property goods and limitations on consensual action; and the behavioral patterns of individual farmers. It bears repeating that the existing literature warns that no social forestry project can be conceived and prepared without in-depth and timely recognition of at least these three sets of social variables.

Project planning must also include the projection of the effects of changes that would come about over time. For example, increase in population density without commensurate productivity growth would reduce the per capita benefits over time. Changes in the opportunity cost of labor can come about due to an increase in cropping intensity as a result of, for example, better irrigation facilities. Similar effects may occur due to opening up of other income generating activities as a result of better roads and transport facilities to nearby towns. In response, the community members may be less inclined to devote time for forest protection, breaking down the collective adoption norm. These peculiarities will be location specific, and therefore attention will be required at the planning stage for each individual program.

Farm Forestry Programs

The Farm Forestry program was designed in the late 1970s, in response to the directive of the National Commission on Agriculture, 1976, which stated that public forests were no longer able to provide fuelwood for the growing rural population and therefore the rural households must grow and use their own trees. The program laid out the apparent ease with which poor people could in this way meet their own basic needs for food, fuel, fruit etc. from their own resources. The weakness of this concept stemmed from its failure to relate it to the farmers' other objectives, and to alternative uses of their resources. The growing of trees always involves some cost in terms of land, labor and capital invested. The produce of trees therefore has a real value to the farm household. There will always be alternative fuel supplies that are less costly for those for whom one or more of these factors of production are scarce resources, and there will nearly always be uses to which these tree products can be put that have higher value than as fuel.

However, the project design assumed that farmers would plant trees to meet subsistence needs as though they were divorced from and immune to market forces. The program dissuaded the farmers from selling their produce on the grounds that it was contrary to the service function assumed to be the goal of Farm Forestry. In reality, Farm Forestry spread quickly in most parts of the country, raising hopes in the minds of the forest sector planners, but enthusiasm among the farmers died out shortly. Learning from the initial experience of the Farm Forestry program, we shall identify the areas which must be addressed for the program to succeed in the long run.

The Farm Forestry program was also criticized because initially big farmers were in the forefront to grab the advantage of free distribution of seedlings (Java, 1986). However, for adoption of innovative ideas of a change from traditional practices, it is always the bigger and richer farmers who could afford to provide the start-up capital, take financial risks and an active interest. As such, as long as the expected trickle-down effect exists, large farmers can only assist in the success of the program by early adoption.

Moreover, much poverty is associated with landlessness and near-landlessness. In West Bengal, 30.3% of the population was below the poverty line in 1987-88 (UNICEF, 1991). About 10% of the population is landless, 70% occupies marginal holdings of less than 0.42 hectares, while another 28% holds small holdings of between 0.42 and 2.68 hectares (Ministry of Agriculture, 1992). Where the household does not have access to land, private tree growing evidently can not have a significant role in alleviating poverty. The range of situations in which tree growing is a viable option for poor farmers with access to a small amount of land is also limited by the need for annual rather than periodic income, and by the priority they attach to ensuring household food security. To pursue tree growing by poor farm households as primarily a vehicle for poverty alleviation is therefore not promising.

Why Plant Trees?

Tree planting by rural households on private land can be theoretically explained as a response to the following dynamic changes:

(i) To maintain supplies of tree products as production from off farm tree stocks declines due to deforestation. This includes mainly fuelwood and some nontimber forest products,

(ii) To meet growing demands for tree products as population grows, the economy grows, literacy increases, and new uses for tree outputs emerge, as a result of which markets develop,

(iii) To help maintain agricultural productivity in face of declining soil quality or increasing damage from exposure to sun, wind or water runoff,

(iv) To contribute to risk reduction, to even out peaks and troughs in seasonal flows of produce and income, and in seasonal demands on labor, to provide a reserve of biomass products and capital available for use as a buffer in an emergency.

Each of these factors are addressed individually.

Supply of forest products for own use

As we have seen extensively in this study, incentives for producing or purchasing fuelwood are very low among the rural communities. It is true that off farm tree stocks have diminished due to deforestation, but the "tragedy of the commons" explains the behavior of the households to continue acquiring fuelwood from open access lands. Participatory Forest Management continues to allow free fuelwood removal from public forests, although in a comparatively restricted manner, under the watchful eyes of the Forest Protection Committees. Therefore, tree planting on private land as a response to declining off farm tree stocks is not valid in the case of West Bengal in particular, as well as India, in general.

Meeting growing market demand

The intentions of farmers adopting Farm Forestry were clear from the beginning: they wanted to produce trees as a profit making venture, to meet the growing market demand. Therefore, prices that could be obtained by selling the wood was the most important information to the farmers in their decision making process. The setback to the Farm Forestry program occurred when the producers either did not get the expected price or could not access the market. Reasons for these problems were explained in Chapter II.

Maintenance of agricultural productivity

Scherr (1993) reports that Kenyan farmers have increased the growing of on-farm trees to provide windbreaks and thereby increase agricultural productivity. However, Saxena (1990) reports that the situation in India is quite the opposite. He found that one of the factors behind the decision of farmers in Uttar Pradesh to discontinue plantings, was their observation of crop losses in the vicinity of the predominant *Eucalyptus* plantations, although there is no evidence of crop loss in case of other tree species. The observations suggest that externalities of tree plantations may be positive or negative. The appropriateness of species selection may be an important factor in determining whether the externalities will be positive or negative. We can conclude, however, that in India, expectations of improved agricultural production have not been a factor inducing tree plantings on private lands.

Risk reduction

Although there is a total lack of studies to examine the relation between risk perception and tree planting decisions among Indian farmers, it is reasonable to believe that diversification into tree farming does affect or is affected by the risk perception among farmers. Hesitation among many to adopt tree planting after the initial setback of the Farm Forestry program could be partly explained by the perception of high risk in the minds of the farmers.

From the above arguments, it appears that the two relevant factors guiding adoption of tree farming among rural households are profitability and risk perception.

Profitability

The net returns from tree farming compared to the net returns from crop farming will clearly play a major role in the farmers' decision to adopt Farm Forestry. However, a direct comparison is difficult. Productivity of tree plantations is less affected by factors such as quality of land, availability of water and climatic conditions, compared to most crops. Tree farming is less labor intensive than most crops, and does not need frequent monitoring, which makes it more suitable for families without surplus labor. On the other hand, the long gestation period of trees compared to crops makes tree farming more suitable for those with higher household food security and alternative income sources, enabling them to invest in such long-term activities. Therefore, the decision between crop farming and tree farming depends on the specific aspects of land, available infrastructure, household attributes, some of which affect the net revenue obtainable, while others are guided by the socioeconomic characteristics of the household.

The quality of the wood produced is a function of the soil and climatic conditions, quality of the seedlings used, spacing and maintenance and the cycle of rotation. The revenue accruing to the farmer is a function of the price, quality and quantity of wood produced. The price obtained by the farmer is a function of the aggregate demand and supply schedule and the producer's access to markets. We shall look into each of the above variables systematically.

Climatic conditions are beyond intervention, while the other factors can be controlled. When Farm Forestry was introduced, the perception that fuel shortage needed urgent action, on a massive scale, resulted in over ambitious planting or seedling distribution targets, priority being accorded to quantity rather than quality or appropriateness. Seedlings were solely distributed by the government at no charge from their own nurseries. A few private nurseries sprang up during the initial period of excess demand, but the quality of their seedlings was low as well. As a result the quality of the wood produced was inferior. For Farm Forestry to succeed, high quality seedling production and distribution is crucial. Banerjee (1994) argues that due to the free seedling distribution program, private nurseries are discouraged, although it is perhaps not possible for the public sector to produce large quantities of quality seedlings. The problem of proper seedlings remains unresolved (Lele et al., 1994).

Technical aspects of tree farming are also crucial for producing quality wood. Saxena (1992) argues that due to expectations of profit, farmers tended to plant too closely and without caring for proper soil preparation. These factors, coupled with low quality of seedlings, result in low diameter of the poles. The West Bengal Forest Department provides technical support to all farmers interested in tree farming, at no cost. It is likely that as farmers become more experienced in tree farming, they will be able to grasp and apply correct techniques while planting trees. Therefore, the quality of wood, which was one of the primary reasons for the low price that farmers obtained earlier, is likely to improve, and wood from private farms should be more "marketable."

The cycle of rotation determines the size of the poles that are obtained. The price of poles is an increasing exponential function of the diameter, whereas the diameter itself is a decreasing exponential function of time. The private discount rate of the producer is an important determinant of the cycle of rotation.

To measure the difference in revenue due to different rotations, we will consider a hypothetical case, dictated by availability of data, where a tree farmer was growing Sal trees in two plots. Plot A was harvested after 10 years and Plot B after 15 years. We use the initial harvest data from the Arabari model (Bardhan Roy, 1992), whose production and price schedule were as follows:

(1) Diameter	(2) # in A	(3) # in B	(4) Price	(5) Rev. A	(6) Rev. B
3	520	0	15	7800	0
4	244	520	50	12200	26000
5	32	244	110	3520	26840
6	4	32	150	600	4800
7	0	4	180	0	720
TOTAL	800	800		24120	58360

Column (1):	Diameter of the pole (in inches)
Column (2):	Number of poles from Plot A
Column (3):	Number of poles from Plot B
Column (4):	Price per pole (In Rupees; we assume constant price in this example)
Column (5):	Total Revenue from Plot A (in Rupees)
Column (6):	Total Revenue from Plot B (in Rupees)

Plot A represents the real values observed in the Arabari model when harvested at the end of 10 years. We hypothesize that an identical plot (Plot B) was harvested after 15 years.

We assume that all the trees grew by one inch in diameter between the 10th and 15th year. This is a conservative assumption. The observed growth rate is 1.4 inches between the 10th and 15th year. The price schedule is the one obtained at the end of the first rotation at Arabari. The total revenue for Plot A after 10 years and the total revenue for Plot B after 15 years are presented in Column (5) and (6) respectively.

The total revenue in Plot B is significantly higher than in Plot A. Given this revenue schedule, the tree farmers would decide on the rotation based on their discount rate. For the above schedule, it is calculated that farmers would be indifferent between the two rotations if their discount rate was 19.8%. For discount rates lower than 19.8% they would prefer the 15 year rotation, while for higher discount rates, the 10 year rotation would be preferred. If the 10 year rotation of the Participatory Management program is a guide, we can conclude that the private discount rate is above 19.8%. However, in case of private plantations, as opposed to community forests, discount rates may be lower because of the sense of tenure security and higher control over the production system.

The reasons for market failure in case of industrial wood was explained in Chapter 2. Only additional obstacles to proper markets, specifically for tree farmers, are discussed here.

Market research, market information and development have so far not been given a serious thought in the forestry sector, according to Palit (1993). Promoting tree growing as a response to perceived subsistence needs has failed to match project production to market possibilities, or to link producers to markets. Interventions have instead centered on provision of free or subsidized planting stock. This continued weakness will limit the success of the Farm Forestry program.

Private producers are frequently subjected to controls on harvesting, transport and sale, designed to protect against illegal felling for sale from government forests. To prevent illegal extraction from government forests, a transit pass is issued by the Forest Department for all legally purchased wood products (World Bank, 1992). These passes are required to transport wood products from one region of the state to another. This system has been in operation since 1959, and has been successful to a certain extent in preventing illegal extraction from public forests. The system was without any drawback till the time when forest products were being produced for commercial purposes on private lands. Resulting cumbersome and costly bureaucratic procedures have led to dependence on intermediaries, and often to fragmented and inefficient marketing structures. This acts as a disincentive for new entrants. Indeed, Banerjee (1994) observes that rich farmers with a long tradition of cash crop production and dealing with market intricacies, perform significantly better in Farm Forestry enterprise.

Impediments on the demand side and difficulties in farmers' access to markets, distorts market price for tree products. Lack of market information, poorly functioning trading systems serving small producers, competition from subsidized supplies from government forests, fuelwood prices depressed by subsidies to alternative fuels, and restrictions on private harvesting and trade, may inadvertently interfere with the shift from a subsistence to a market economy.

Risk Perception

Forest management deals with the future, and therefore uncertainties and risks evolve. A situation involves risk if more than one outcome is perceived to be possible from any given action. Two types of risks affecting tree farmers can be distinguished: (1) Risks arising out of production uncertainty due to factors beyond the control of the farmer, such as freezes, drought or pests that would affect quantity and quality of wood produced, and (2) Risks due to market uncertainty because of fluctuating prices and limited price information. The longer the time horizon, the longer the forecasts that need to be made and the greater is the perception of risk.

While the degree of risk aversion affects all sectors of the economy, the forest sector is more seriously affected for a variety of reasons. First, investments in tree planting have much longer gestation periods than investments in agriculture or industry, and the longer the gestation period the more are the risks involved. Second, wood prices are subject to more violent fluctuations than other commodities, due to cyclical gluts and shortages, and thus they are difficult to forecast. Last, some wood products could be replaced by cheaper substitutes due to technological change, which would lower the market price of wood.

The unexpectedly low price that tree farmers in north India could obtain during the early 1980s (Saxena, 1992) due to an unexpected poor quality of the wood produced and the glut in the wood market, the news of which quickly spread all over the nation, has made risk perception a major factor in farmers' decision making for adoption of Farm Forestry. Banerjee (1994) observes that poorer farmers are more risk averse and do not risk tree farming as an alternative to household food security. Policies to reduce the perception of risk in the minds of the farmers can be conceived. They are presented later.

In the following chapter we will investigate the process of change in consumption and production of forest products over time. The ability of the Forest Department in overcoming the challenges in implementation of the new programs on a statewide basis, as brought forward in this chapter, will determine how much of the production possibility, under the existing physical and technical constraints, will be ultimately harnessed. The future of West Bengal's forestry sector, therefore, depends to a great extent on the issues that were presented and analyzed in this chapter.

CHAPTER IV

ANALYTICAL METHODS FOR ESTIMATION OF FUTURE REQUIREMENTS AND PRODUCTION POSSIBILITY OF FOREST PRODUCTS

Rigorous analytical studies to estimate future requirements and production possibilities of forest products in India have not been performed as yet. Available estimates for future requirements are based on surveys and population projections assuming constant per capita consumption. However, population growth is not the only variable that explains growth in forest product consumption. Here, more insightful models are built to estimate future requirements. Production possibility estimates over time, on the other hand, are documented in the literature, based on the productivity of different forests. Here, production possibilities of the various management programs will be aggregated on a statewide basis, to enable comparison with the estimated requirements.

The estimation of requirements over time also provides an understanding of the nature of the change in requirements in relation to the change in explanatory variables. This understanding will be useful for policy formulation. For example, it will help in the decision to prioritize the need for increased production and demand reduction strategies among the different forest products as their composition of consumption changes over time. It will also expose the importance of forces outside the forestry sector in tackling forestry problems, and the relative emphases among them, that are needed to reduce the shortfall for different forest products.

First, models to capture the path of increasing requirements of fuelwood and industrial wood over time are presented. Then, the production possibility of forest products are investigated under the optimistic assumption that the full program is implemented by the West Bengal Forest Department and that it leads to productivity growth commensurate with physical production possibility, although in the previous chapter the various constraints that will have to be overcome in order for the programs to succeed are analyzed.

In case of livestock, only an analytical understanding of the sector is provided. Similarly, for nontimber forest products, the nature of their consumption for subsistence is presented.

Time Horizon

The estimates of future consumption of forest products in this analysis have a time horizon of 15 years. The justifications for selection of this time horizon are as follows:

(i) The current forest sector programs in West Bengal, being implemented after the 1988 National Forest Policy, have a planning horizon of a maximum of ten years for each rotation. The level of success of the programs could be assessed at the end of the first rotation, which will be in the next five years for some areas, and by the year 2010 for those that are implemented in the next five years. Therefore, it can be said that the first phase of a majority of the programs statewide will have completed one cycle by the year 2010. The overall success of the program, as measured by the ability to reduce the shortfalls in fuelwood and industrial wood could be assessed at that time. That would also be an appropriate time for revising policy and program designs based on the experience of the first phase. The goal of this analysis is to investigate the status of the forest product requirement and availability situation under the current programs, which are likely to change after the year 2010 due to revisions based on implementation experience gathered during the first phase.

(ii) The change in consumption of fuelwood and industrial wood depend on a number of variables, as presented later. Estimation of the path of these variables is expected to be closer to reality in the relatively short run. This is more so because of the major economic reforms that are underway in India in the last few years. Therefore, it will be less meaningful to estimate forest product requirements based on projected values of explanatory variables in the long run.

(iii) It can be argued that after a certain level of economic development, the relationships that currently capture the consumption pattern of forest product use, will themselves change. For example, the subsistence nature of many forest products may not remain so after infrastructural development leads to more organized markets, competition and better information. This may be further accentuated by opening up of off-farm employment opportunities in rural areas, raising the opportunity cost of labor, due to which activities such as fuelwood collection may become relatively unremunerative. Therefore, analysis of forest products usage in the long run may be better performed by different behavioral models than the ones developed here.

Estimation of Requirements for Forest Products

Fuelwood

The objectives of this study for estimating future fuelwood requirements for the state of West Bengal are:

(a) to compare the future requirement to the production possibility in order to understand the level of scarcity that will prevail in the future, and,

(b) to understand how the aggregate requirement may be reduced by policy induced changes that reduce population growth, increase per capita income of the poorer sections that are dependent on fuelwood, and promote fuelwood substitution and more efficient methods of combustion.

The estimated aggregate requirement for fuelwood is postulated as follows:

$$F_t = F\ (F_0,\ Po_{t\text{-}0},\ Y_{t\text{-}0}),$$

where

F_t = Estimated aggregate requirement of fuelwood in year t,

F_0 = Aggregate requirement of fuelwood in the base year,

$Po_{t\text{-}0}$ = Estimated population in year t/ base year population,

$Y_{t\text{-}0}$ = Estimated per capita income in year t/ base year per capita income.

Before justifying the inclusion of the above independent variables as determinants of the future requirement of fuelwood, the assumptions behind the structure of the model are outlined. First, the factors affecting the base year consumption of fuelwood at the household level, other than population and income, are captured by the variable, F_0, and are implicitly assumed to remain unchanged. However, later in the analysis, the effect of changes in two of them, namely, price and availability of kerosene, and the adoption of fuel efficient stoves, on the future aggregate fuelwood requirement are investigated. There are some other variables that affect fuelwood consumption, but literature presented earlier, based on micro studies, asserts that their effects are insignificant. Such variables include distribution of size of household holdings and number of improved cattle among households with no surplus labor, which are not incorporated in this model.

Consumption in the base year

The base period consumption level measures the consumption pattern at an aggregate level of fuelwood users in West Bengal. The inclusion of observed base period consumption as an explanatory variable for future consumption captures all the region specific behavioral factors that are difficult to include in direct demand estimation models. However, an implicit assumption in this approach is that those behavioral variables remain constant over the period of the analysis.

As explained in the second chapter, there is no consensus on the current level of fuelwood consumption for the state of West Bengal and for the nation. This is primarily due to the difficulties in measurement of the enormous fraction of fuelwood that is obtained from unrecorded fellings, as is apparent from the ratio of consumption to recorded production of 24:1 for West Bengal and 9:1 for the nation (Chakrabarti, 1989). This is corroborated by others in the literature as explained in the second chapter. There are two estimates for fuelwood consumption in West Bengal. The Wood Balance Study, based on a direct survey of fuelwood consumption in West Bengal, estimated a fuelwood consumption level of 13.25 million tons for the state in 1990. On the other hand, the Advisory Board on Energy (Government of India, 1985) estimated a future consumption level of 13.5 million tons in the year 2004/05 for West Bengal, based on assumptions of fixed per capita energy consumption for the nation, energy efficiency of fuelwood and population growth. Clearly, the two estimates are inconsistent with each other. The Wood Balance Study estimates are used for consumption in the base period. The reasons for preferring the Wood Balance Study estimates over the Advisory Board estimates are as follows:

(i) It obtained the estimates from a direct survey of more than 18,000 households in the state of West Bengal, whereas the Advisory Board Study assumed a fixed per capita energy demand for the nation, without differentiating between the variations in forms of fuel used in different regions of the country,

(ii) The Advisory Board study assumed a fixed 8% thermal efficiency of fuelwood combustion which in reality may vary from region to region based on the predominantly used tree species, climate, prevailing style of stoves used, food habits, etc.,

(iii) The Advisory Board Study did not account for the contribution of fuelwood substitutes, except dung cakes, which are prevalently used, such as shrubs, bushes and agricultural wastes, and

(iv) Methodologically, a region specific survey is preferable to application of a national survey results to a region, because regional peculiarities are likely to be better captured by the regional study.

Lack of consensus of fuelwood consumption figures for the base period, for reasons explained above, is certainly the biggest limitation of this analysis. However, this problem is encountered repeatedly among researchers and policy makers in this area, as explained by Dwivedi (1994). The nature of policies required to address the problem is dependent on the magnitude of the scarcity, which is affected by the above imprecision. However, an understanding of the process of change is the major goal of this investigation, which is not lost due to the imprecision in data on consumption level.

Population growth

The rate of growth of population of the state is the most important variable for determining future fuelwood consumption. The annual population growth rate of West Bengal between 1981-1991 is calculated to be 2.58% in urban areas, 2.11% in rural areas and 2.237% combined (Using population census figures as reported in Ministry of Agriculture, 1992). However, the population growth rate is expected to decline. The Government of India (1993) estimates a growth rate of 1.6% nationally, and 1.4% for the state of West Bengal, for the period 1991-2001. Bos et al. (1994-95) reports the United Nations population projections for India and estimates a growth rate of 1.79% for the same period. However, the distribution of population growth between the rural and the urban areas is not available in the Government of India or the United Nations estimates.

The Wood Balance Study (Government of India, 1984) found that 93% of the fuelwood is consumed in the rural sector. Therefore, a weighted average of the urban and rural population growth rates (in the ratio 93:7), which represent the growth in fuelwood consuming population, would be most appropriate to estimate the population level in the year t. The weighted average incorporates the effect of rural-urban migration on the total fuelwood consumption of the state. Therefore, in this analysis, the differential between the rural and urban growth rate observed in the 1981-91 figures given above, is applied to the estimated population growth rate of the Government of India for the period 1991-2001, to estimate the weighted average. The implicit assumption is that the observed rural-urban migration rate between 1981-91 will remain constant for the period of this analysis. Using this method, the estimated rural population growth rate is 1.32% and the urban population growth rate is 1.61%. Therefore, the weighted average population growth rate comes to 1.34% per year. An alternative scenario, based on the assumption that the observed population growth rate of the decade of 1981-1991 remains unchanged for the period of this analysis, is also presented. This provides understanding of the contribution of population growth rate towards the magnitude of future fuelwood shortage.

The increase in population will increase the total consumption of fuelwood. The elasticity coefficient of the population growth variable has been assumed to be 1, which implies that the per capita consumption of fuelwood, all other factors remaining unchanged, is assumed to be constant over the period of this analysis. Also, an implicit assumption is that the population growth rate is constant among all households, irrespective of their level of fuelwood consumption.

Growth rate of per capita GNP

The current growth rate of per capita GNP in India is 3.1% per annum (World Development Report, 1994). The increase in per capita income at low levels of income is not likely to change fuelwood consumption by a significant amount, as established in the literature already presented. However, as income continues to increase, and is above a certain threshold, fuelwood consumption is expected to decrease due to negative income effects, as expected in case of inferior goods, given other factors remaining unchanged. Although the literature strongly asserts the theory of inverse relation between income and fuelwood consumption for a certain income range, estimates of the threshold income level at which households reduce fuelwood consumption and increase the use of superior fuels is not available in the literature. The threshold level itself can be argued to be a function of household characteristics such as the number of dependents, the availability of surplus labor for fuelwood collection, access to markets for superior fuels, and prevailing custom.

According to Natarajan's (1985) estimate, as income went up, 0.78% of the rural population and 5.28% of the urban population in West Bengal switched fuels in the last five years, of which 65% were fuelwood users. Once again, by computing a weighted average of the rural and urban population who switched from fuelwood, the aggregate annual percentage of the total population who switch from fuelwood to other fuels works out to 0.14%. However, the distribution of income growth by income classes affects the number of rural people using fuelwood, as is apparent from the following information for West Bengal:

Income	(1)	(2)	(3)
0 - 3000	4633	0.424	
			1.60%
3000 - 6000	1737	0.417	
			8.30%
6000 - 12000	1019	0.385	
			1.35%
12000 - 18000	87	0.380	
			3.50%
18000 - 24000	54	0.367	
Total	7530	0.368	

(1): Distribution of sample households (rural) by income for West Bengal (Natarajan, 1985)
(2): Per capita fuelwood consumption (in cubic meters) by sample households (rural) by income (Wood Balance Study, 1984)
(3): Percentage of decline in fuelwood consumption between income groups (calculated from 2)

It is apparent that the maximum substitution occurs for the population class whose income increases from Rupees 6,000 to Rupees 12,000. Therefore, if the per capita income of the poorer classes increases faster than that of the relatively richer classes, more fuelwood substitution will result.

In this analysis, the effect of income growth on future fuelwood consumption is considered under three different scenarios based on assumptions of the distribution of income growth among income classes.

For the first scenario, it is assumed that the income growth is evenly distributed among all income classes. In this scenario, Natarajan's (1985) observation, presented above, for the fraction of the population that switched from fuelwood to other fuels as incomes went up, is used to simulate the future consumption level of fuelwood.

In the second scenario, under the same assumption of even income distribution among all income classes, the findings of Chakrabarti (1989) given in the above table is used for the simulation. The difference in the estimates of fuelwood requirement under these two scenarios are very insignificant. Therefore, the result is presented as Scenario 1.

In the next scenario, it is hypothesized that the rate of growth in per capita income is skewed in favor of the lower income classes. This is based on the notion that policies towards equitable income distribution will yield results and lead to an inverse relationship between rate of growth of income and income level. More specifically, it is assumed that the population whose annual income was below Rupees 12,000 (US$ 400) in the above table will have a rate of growth of income of one and a half times the current rate of growth of per capita GNP, while for the rest of the population, the per capita GNP will be three-fourths of the current rate of growth. This is a hypothetical exercise, performed due to the lack of data on distribution of income growth in the past or estimates of the distribution of future income growth. An alternative assumption of using information on changes in income distribution from other countries with similar income distribution characteristics as India was considered. However, it was not pursued because there is no reason to believe that using such information would lead to better estimates, because of the differences in income distribution policies, agricultural productivity levels, cultural attributes and habits of the rural population etc.

It is important to note that since this is a hypothetical case, it should not be interpreted as an estimation of future fuelwood consumption. The aim is to simulate the future consumption under this situation to investigate the question that if policy induced rate of growth of income could reach these levels, how much would the fuelwood scarcity diminish as a result. The results of this scenario is presented as Scenario 2.

In this scenario we also use the findings reported by Chakrabarti (1989) given in the above table for the relation between fuelwood consumption level and income class. It must be noted that the findings given above are the results of a cross-sectional study at one point in time. Therefore, the relation between income level and fuelwood consumption established may not be completely consistent with actual fuelwood substitution behavior as per capita income rises over time. This remains a limitation of this approach which could not be remedied.

Price and availability of substitutes

The only substitute among superior fuels that can reduce fuelwood consumption in rural West Bengal is kerosene. However, kerosene usage in rural India is limited. Natarajan (1985) found that even the population belonging to the highest income group (Rupees 18,000 and above yearly) met 82.3% of their fuel needs from noncommercial fuels. Price of kerosene is statutorily fixed by the government but the price in rural areas in West Bengal is 50% higher because of added transport costs. The average distance to the nearest outlet in West Bengal is more than 2 kilometers, and availability is irregular (Natarajan, 1985). Under the circumstances, the opportunity cost of labor to collect fuelwood in a labor surplus state is likely to be less than the price of the kerosene plus the opportunity cost to procure it. This results in the low kerosene usage (Molnar, 1992).

Natarajan (1985) investigated the role of kerosene used for heating and for lighting. From a survey of kerosene users, he could establish a positive relation between kerosene consumption and income, and a negative relation between price and the distance traveled to obtain it. Therefore, unlike fuelwood, kerosene exhibits characteristics of a normal good, and is a nonpolluting superior fuel. A number of studies, explained in the second chapter, have established that in urban areas with a higher opportunity cost of labor, kerosene is not a more costly fuel to use than fuelwood. The main constraint to the low kerosene usage, as revealed by the literature, is availability. It can be argued that if distance to kerosene outlets is smaller and availability is regular, the threshold level of income at which fuelwood consumers shift to other fuels, mainly kerosene, will go down.

Efficiency of combustion

Thermal efficiency of combustion, such as in cooking stoves, determines the amount of fuelwood required to produce a given amount of energy. Chakrabarti (1989) estimates that the thermal efficiency of conventional stoves is 10%-12%, whereas the efficiency of improved stoves is as high as 30%-50%. The Advisory Board on Energy (Government of India, 1985) found the efficiency of conventional stoves to be 8%. Therefore, the energy obtained from efficient stoves could be as much as 3-4 times higher than conventional stoves. Adoption of fuel efficient stoves on a large scale can reduce the fuelwood consumption very significantly. This is corroborated by Amacher et al. (1993) from their case study in Nepal.

The West Bengal Directorate of Social Welfare and the Department of Nonconventional Energy launched programs to promote efficient cooking stoves, in order to reduce fuelwood consumption. Although 54,000 improved stoves were installed until 1989-90 in West Bengal (World Bank, 1992), the program has not had much success due to organizational problems. Dwivedi (1994) reports similar problems on a national level. Therefore, policy thrusts towards adoption of improved stoves are clearly called for. The consumption of fuelwood will be greatly reduced over time if the program can be successfully adopted.

Industrial Wood

Industrial wood can be broken down by end use following an elaborate set of classifications developed by the Food and Agricultural Organization (FAO), and reported by Kumar (1994). However, generalized models, as reviewed earlier, have been developed at various levels of aggregation to investigate the dynamics of industrial wood consumption. The Wood Balance Study (West Bengal Forest Department, 1984) broke down industrial wood by the most important end uses in the state of West Bengal, namely, for paper mills, match factories, tea chests, coalmines, and other industries comprising of construction, furniture, transport, railway sleepers, transmission poles, agricultural implements and other sundry uses.

Data for the production of industrial wood, however, is not aggregated in a way that is consistent with end use. This is because many end uses of wood allow for substitution of other kinds of wood. For example, traditionally bamboo used to be the major raw material for paper mills. However, bamboo production in West Bengal have gone down over time, while other end uses of bamboos, such as scaffolding, has gone up (World Bank, 1992). As a result, paper mills substitute a number of softwood species for bamboo. Also, within the same tree species, end use of the timber harvested varies depending on characteristics of individual trees, such as thickness, posture, and length. These factors make it impossible to classify quantities of industrial wood produced in terms of specific end uses.

In developing the model to estimate future consumption of aggregate industrial wood, the basic structure suggested in the seminal paper by Gregory (1966) and widely applied, including by Buongiorno (1977) in FAO projections for both developed and developing countries, is used. Their work has been discussed in the second chapter. Their models are general enough to estimate industrial wood consumption at the aggregate level, because according to them, the important explanatory variables that alter the consumption of industrial wood over time, apply to all types of timber. Although the elasticity coefficients would vary to a certain extent when applied separately to data disaggregated on the basis of end use, sufficient homogeneity exists for researchers to estimate overall elasticities, as presented earlier. This analysis will follow the aggregation dictated by the form of available data. However, in cases where it is possible to improve the quality of analysis by applying more disaggregated information that is available, it shall be attempted, as will be explained when the model is presented.

Using this approach also fits Gregory's argument that the estimated requirements of future industrial wood would indicate the level of development from a productivity standpoint that will be required if industrial wood consumption is to be maintained at the necessary level to provide for the requirements of the manufacturing sector. In postulating the model, the set of explanatory variables have been constructed using results from Gregory (1966) and Buongiorno's (1977) as well as additional variables which arguably would affect wood consumption in the Indian situation.

The estimated aggregate requirement for industrial wood is postulated as follows:

$$I_t = I\ (I_0,\ Y_{t-0},\ Po_{t-0},\ L_{t-0},\ (Ma-G)_{t-0}),$$

where

I_t = Estimated aggregate requirement of industrial wood in year t,

I_0 = Aggregate requirement of industrial wood in the base year,

Y_{t-0} = Estimated per capita income in year t/ base year per capita income,

Po_{t-0} = Estimated population in year t/ base year population,

L_{t-0} = Estimated number of literates in year t/ number of literates in the base year,

$(Ma-G)_{t-0}$ = Estimated GNP in the manufacturing sector/ estimated overall GNP in year t/ GNP in the manufacturing sector /overall GNP in the base year.

Consumption of industrial wood is expected to rise over time as a result of growth in each of the above explanatory variables.

The consumption of industrial wood is made up of two components. First, there is a direct consumer demand for household furniture, construction and paper, and second, there is a derived demand due to manufactured goods that use wood as an input such as in industrial construction, transport, packaging, and paper. The variables which shift future consumption affects one or the other or both of the above demands. Therefore, although the above model specification is for aggregate industrial wood consumption, the effect of some of the exogenous variables will be restricted to only a portion of the aggregate wood consumed. This is explained below, with the explanation of the dynamics of the relationship between wood consumption and individual explanatory variables.

Consumption in the base year

As pointed out by Gregory (1966) and reported in the second chapter, using observed current consumption as an explanatory variable to estimate future consumption captures the region specific behavioral factors which can not be explicitly included in generalized models. However, the implicit assumption is that the behavioral factors remain constant for the period of the analysis.

Estimated figures are available from the Wood Balance Study of the West Bengal Forest Department for the aggregate requirements of industrial wood as raw material for industries and for direct consumption, based on the installed capacity of the machinery and observed consumption. The paper mills in West Bengal operate well below their installed capacity due to unavailability of raw material (World Bank, 1992). According to the Wood Balance Study, the annual demand for aggregate industrial wood in 1990 stood at 2.62 million cu.m. The per capita annual consumption of pulp and paper is reported to be 3.2 kilograms. These figures for the year 1990 will be used as the base period consumption level.

Per capita GNP

The current growth rate of per capita GNP in India is 3.1% per annum (World Development Report, 1994). The rise in per capita income is expected to increase both the direct demand for wood for household goods as well as derived demand for wood as a result of increased demand for manufactured goods which use wood as an input.

The relationship between change in wood consumption and growth of income has been investigated by Gregory (1966), Buongiorno (1977), Buongiorno and Grosenik (1977) and Kumar (1994). All of them agree that per capita income growth is an important shifter of the level of per capita industrial wood demand. Gregory contends that many studies which assume income elasticity of wood consumption to be unity have no basis to do so. There is consensus in the literature that the rate of growth of aggregate industrial wood demand is related to both the rate of growth of income as well as the level of income. This translates to the income elasticity of demand for industrial wood being a function of the level of income.

Dilip Kumar (1994) presents four different model specifications to relate industrial wood consumption and income. They are

1) Double log: $\ln C = a + b \ln Y$

This model is most applicable for a situation as in India. Kumar points out that it is suitable for economies where industrial wood consumption is low and is far below saturation limits. It displays constant elasticity with respect to income, the coefficient of elasticity being given by the parameter b. The application of this model is also consistent with the findings of Gregory, Buongiorno and Buongiorno and Grosenik. According to them, developing countries with relatively low wood consumption exhibit high income elasticity until a saturation limit is reached, when the elasticity starts to decline. The decline is explained by the fact that at higher levels of income people substitute bricks, glass and aluminum for wood, which is observed in developed countries.

It can be argued that as industrial wood consumption in India increases over time, a decline in income elasticity will be observed after the consumption crosses a certain level. However, the current per capita wood consumption in West Bengal (estimated to be 60 cu.m. per 1000 people in 1990, according to the Wood Balance Study) and in India is low (belongs to the lowest category considered by Gregory--

countries with per capita income of less than $500) and the saturation limit is not likely to be reached during the period of this analysis. This provides justification for the contention that the income elasticity derived from this model specification is appropriate for the purposes of this analysis.

Kumar's estimates using this model at the aggregate level obtain an income elasticity coefficient of 2.27. This can be argued to be consistent with Gregory's estimate of income elasticity of 1.22 for countries with per capita income of $500, because per capita income of West Bengal is significantly lower at about $100. Therefore, an income elasticity coefficient of 2.27 has been assumed for this model.

2) Semi-log: $C = a + b \ln Y$

In this case, the coefficient of elasticity is inversely proportional to consumption and is given by b/c. Therefore consumption is expected to fall as income grows as in the case of inferior goods. This specification is unsuitable for industrial wood consumption in developing countries. It may be applicable in cases where per capita income and consumption is high and additional income results in substitution of wood for other superior substitutes such as metals.

3) Log-inverse: $\ln C = a - b/Y$

In this case also, the coefficient of elasticity falls with income, and is given by b/Y. It applies to those goods for which consumption is already high, but still increases moderately with income, although consumption is close to the saturation limit. This specification is also not applicable for typical developing country situations.

4) Log-log-inverse: $\ln C = a - b/Y - c \ln Y$

In this case, the coefficient of elasticity is given by $(b/Y) - c$. It is a bell shaped function. As income rises, consumption rises, as in the case of luxuries, and then declines, as in the case of inferior goods. The path of the consumption function at initial income levels may be applicable to the situation being considered here, but the shape of the function changes to a declining function as income grows. This decline can be expected in India after a long period of time when wood consumption has peaked and further income would lead to declining consumption. Therefore, this specification would be suitable for forecasting wood consumption for a very long period of time, and not for the time horizon of this analysis.

Population growth

The population of West Bengal increased at a rate of 2.237% per year between 1981-91 (census figures as reported in Ministry of Agriculture, 1992). However, both the Government of India (1993) population projection (available at the state level) and the United Nations population projection for India (reported in Bos et al., 1994-95) show a decline in the population growth rate for the period 1991-2001. This analysis provides alternative scenarios of industrial wood consumption level (i) based on the population growth rate of 1.4% per year projected by the Government of India, and (ii) based on the observed growth rate of 2.3% per year for the last decade.

The effect of population growth on aggregate industrial wood consumption has been incorporated by Gregory (1966), Buongiorno (1977) and Buongiorno and Grosenik (1977) by assuming a constant per capita consumption over time, as reported in the review of their works. This assumption is maintained in this analysis, which translates to a coefficient of 1 for the population growth variable, given other factors such as literacy rate and income level of the population remaining constant.

Literacy rate

Literacy rate, which increased from 40.94% of the population of the state in 1981 to 57.72% in 1991 (Ministry of Agriculture, 1992), is expected to have a positive effect on the demand for industrial wood due to increased demand for paper. The annual growth rate of literacy in West Bengal, calculated from the above figures, is 1.035%. Projections for changes in literacy rate for the state are not available. It is assumed that the growth in literacy rate observed in the decade of 1981-91 will remain unchanged for the period of the analysis. Although it can be argued that the growth in literacy rate must slow down as the number of literates in the population approach 100%, the number of years it will take to reach a literacy rate of close to 100% is beyond the period of this analysis.

The Wood Balance Study provides an estimate of 3.2 Kilograms of paper consumption per capita in 1990 for the state of West Bengal. Using per capita paper consumption, the paper consumption per literate person for 1990 is calculated. Based on the assumption that the per capita paper consumption of literates remains constant, the effect of increased literacy rate on future paper consumption is incorporated in the estimate of the future aggregate industrial wood requirement. It must be noted that the effect of increased literacy rate applies only to the consumption of paper and does not have any effect on the consumption of industrial wood used for purposes other than manufacture of paper.

Manufacturing sector GNP

Most of the industrial wood in West Bengal is used in the manufacturing sector. The Wood Balance Study estimates that in 1990, about 87% of the total industrial wood demand was due to derived demand for manufactured goods. The manufacturing sector in India has grown at a faster pace relative to other sectors, as is apparent from a higher growth rate of GNP originating in the manufacturing sector (7.3% per year between 1980-90) compared to the overall growth rate of GNP (5.5% per year between 1980-90) (Figures reported in India: 93-94). Therefore, the additional demand for industrial wood arising out of the higher rate of growth in the manufacturing sector is not captured by the rate of income growth that has already been included in this model. To incorporate this effect, the differential between GNP originating in the manufacturing sector and the overall GNP is used as an explanatory variable. It is assumed that the demand for industrial wood arising from each manufacturing unit is constant as the number of manufacturing units increase. This implies a proportionate increase in the demand for industrial wood as the manufacturing sector grows. Further, the implicit assumption is that the differential between the overall growth rate of

GNP and the growth rate of GNP originating in the manufacturing sector as observed in the decade of 1980-90 will be unchanged for the period of this analysis.

Estimation of Availability of Forest Products

The estimation of availability of forest products performed here represents the technical production possibility frontier under Participatory Forest Management, Farm Forestry and Strip Plantation programs which are underway in the state of West Bengal. Production of forest products is expected to be below the maximum physical production possibility due to difficulties in design and implementation, the reasons for which were explained in the previous chapter.

Forest Types

Productivity of natural forests differs according to forest types, which primarily depends on the ecological regime of the region. Therefore, it is impossible to forecast the aggregate production possibility of natural forests in the state by summing up the estimated production possibilities of every acre of natural forest land. In this analysis, the aggregate production possibility of forest products is estimated by dividing the state into two ecological regimes. Further disaggregation based on differences in ecological regimes would theoretically yield more accurate estimates of production possibilities. However, to do that, the data on forest land available for production must be disaggregated also. The existing available data is disaggregated at the district level. Districts, however, are not broken down by ecological regimes. Therefore, the variations remain within districts as well. On the other hand, many forest lands in different districts spread over the state belong to similar ecological regimes.

The basis for dividing the forest area of the state into two ecological regimes is that the northern part of the state is hilly while the southern part is comprised of plains. Ecological conditions of the hills and the plains are distinctly different. As a result, species of predominant trees are different between the two regions. The average productivity of the predominant trees also differ clearly. Average productivity of predominant tree species in the two regions, has been reported by the World Bank (1992). In the case of Farm Forestry production, average productivity measures are more reliable because they are relatively more controlled production systems than natural forests due to the selective planting of species of choice, and the attention paid to soil preparation at the time of planting.

Vegetation

For the purposes of this analysis, the plains are comprised of the following areas with their respective vegetations (World Bank, 1992):

(i) the central alluvial tracts of districts of West Dinajpur, Malda, Murshidabad, Nadia, Hoogly and Howrah, Burdwan, Midnapore and North 24-Parganas, where the soil is fertile, sandy, and rainfall averages about 1500-1800 mm annually. The main tree species are _Shorea robusta_, _Pterocarpus marsupium_, _Madhuca latifolia_, _Diospyrus melanoxylon_, _Salmalia malabaricum_, _Terminalia_ spp., _Barringtonia acutangula_, _Randia uligionosa_, and _Ficus_ spp.

(ii) the lateritic tract of districts of Purulia, Bankura, Birbhum, Midnapore and Burdwan, where the soil is porous and well drained, and rainfall averages 900-1400 mm annually. The main tree species are _Shorea robusta_, _Diospyruos melanoxylon_, _Lagerstroemia parviflora_, _Mahuca indica_, _Schleichera oleosa_, _Butea monosperma_, _Terminalia_ spp., _Buchanania latifolia_, and _Salmalia malabaricum_.

(iii) The coastal saline zone of the districts of South 24-Parganas and Midnapore, known as the Sundarbans, where the soil is saline and the vegetation is mangrove, with

Avicennia spp., Rhizophora spp. and Sonneratia spp. as the pioneering tree species.

The hills comprise of the following areas with their respective vegetations:

(i) The higher altitudes of the Darjeeling district where the soil is generally rich and receives a high rainfall of above 2000 mm annually. The main tree species in the upper hills (above 2000 meters) are Ouercus spp., Machilus spp., Magnolia cambelli, Juglans regia, Michelia doltsopa and Alnus nepalensis, while the very high altitudes (above 3000 meters) are mainly covered by confers and rhododendron species. The main tree species in the middle hills (1,000-2,000 meters) are Betula spp., Ouercus spp., Phoebe spp., Juglans regia, Castanopsis spp., Albizzia spp. and Michelia spp. The main tree species in the lower hills (below 1000 meters) are Shorea robusta, Terminalia spp., Schima wallichii, Cedrela toona, Chukrasia velutina, Michelia spp., Salmalia malabaricum, Gmelina arborea, Ailanthus grandis, Amoora wallichii, and Mesua ferrea.

(ii) The sub-himalayan areas in Jalpaiguri, West Dinajpur and Cooch Bihar district have sandy soil and receive heavy rainfall of above 3000 mm annually. The vegetation in these areas includes many species which are common in the plains, as the altitude is low. Shorea *robusta* is mixed with *Schima wallichii*, *Terminalia* spp., *Chukrassia velutina*, *Lagerstroemia parviflora*, *Amoora wallichii*, and *Careya arborea*.

Productivity

The productivity of the natural forests in terms of amount of fuelwood and industrial wood produced varies with the composition of the forests. The natural forests are mixed forests, although in many areas in West Bengal the predominant species is *Shorea robusta* (Sal). Therefore, estimation of the overall productivity of any natural forest must be an approximation of average productivities of different species that make up the forest. Such average productivity figures, available from silvicultural records of the West Bengal Forest Department, have been used here.

The rotation that is being followed in general is harvesting 10% of the forest under each Forest Protection Committee every year, which implies a cycle of 10 years. However, the time of the first harvest is decided by the Forest Department and the harvest is done when the degraded forest has sufficiently regained its health. Therefore, there is a time lag before the first harvest. Subsequent to that, 10% of the forest is harvested every year. In the long run, the composition of the forest will be such that at any point in time 10% of the forest will be newly regenerating, 10% will be one year old, 10% will be 2 years old, and so on, while 10% will be ready for harvest. Consequently, there will be a steady production of industrial wood on an annual basis. In case of fuelwood, the more mature trees provide more branches and twigs, and therefore more fuelwood. However, in the long run, since the composition of the total forest land remains constant over time, the annual availability of fuelwood will also be steady.

Productivity of plantation forests, under Farm Forestry and Strip Plantations, exhibit smaller variations than natural forests. Along with _Eucalyptus_, species such as _Acacia_, Subabul, Sissoo and Gamar are also used in these plantations. The productivity of plantation species is easily available. The figures from the West Bengal Forest Department are used here. In case of Farm Forestry and Strip Plantations, the cycle of rotation is decided by the individual farmer or community groups, and varies from 6-10 years for most cases. In this analysis we assume (i) a 8 year cycle, and (ii) therefore, in the long run, the aggregate annual production will be 12.5% of the total production.

The average annual productivities of the different forests under consideration are presented in Appendix IV.

Land Constraint

The above forestry programs aim to cover all available public and private forest lands in the state of West Bengal, which add up to about 2 million hectares (World Bank, 1992). However, only a fraction of the total area available for production has been brought into the forestry programs so far. Therefore, the estimates for production have been adjusted as explained below.

Participatory forest management

Participatory Forest Management is expected to be extended to all public forest lands, other than areas under special protection for ecological reasons. There are about 445,600 hectares of available public forest lands in the plains and 259,800 hectares in the hills for Participatory Forest Management (World Bank, 1992). Only about 30% had been covered by 1992. The time of the first harvest is decided on a case by case basis depending on the health of the regenerating forest. In this analysis, it is optimistically assumed that (i) the first harvest in the 30% area that has been covered before 1992 will be in 1995, (ii) another 20% of the area will be covered by the program by 1995, so that the first harvest in those areas will be done in the year 2000, (iii) another 25% of the area will be covered by the program by the year 2000, and the first harvest in those areas will be done in 2005, and (ii) the remaining 25% of the area will be covered by the program by 2005, so that the first harvest in those areas will be done in the year 2010.

Strip plantations

Only 35,000 hectares, or 23% of available common property lands, had been converted to Strip Plantations by 1992, and another 150,000 hectares are still available for conversion (World Bank, 1992). It is assumed that (i) the first harvest in the 23% covered area will be in 1995, (ii) a combined 40% of the available area will be brought under the program by 1995, for which the first harvest will be in the year 2000, (iii) a combined 70% of the available area will be brought under the program by the year 2000, for which the first harvest will be in the year 2005, and (iv) all of the available area will be brought under the program by 2005, for which the first harvest will be in 2010.

Farm forestry

In the case of Farm Forestry, the West Bengal Forest Department reports that a total of 856,200 hectares of private lands are available, of which 319,900 hectares, or 37% of the area, has already been developed. It is assumed that (i) the first harvest in the 37% of the area already covered will be in 1995, (ii) a combined 50% of the available area will be brought under the program by 1995, for which the first harvest will be in the year 2000, (iii) a combined 75% of the available area will be brought under the program by 2000, for which the first harvest will be in the year 2005, and (iv) all of the available area will be brought under the program by the year 2005, for which the first harvest will be in 2010.

The results of the analysis are presented in the following chapter, which will also provide insights into the effectiveness of the current forest sector programs in meeting the requirements of different forest products users. The results also indicate that factors outside the forestry sector play an important role in forest products requirements, and therefore policy induced changes affecting some of those factors could be beneficial to the forestry sector.

Livestock

The demand for fodder is difficult to define because the large majority of livestock in West Bengal, as in many parts of India, is unproductive. They are reared for the little milk they produce which is justified by the very low maintenance cost because the animals are not provided with any fodder by the owners other than what they can obtain from open grazing. The scope of this analysis is restricted to providing an understanding of the livestock sector in West Bengal, and does not estimate the dynamics of fodder shortage, the reasons for which are explained.

Maintenance of a large number of livestock is clearly not justified from an economic standpoint, as Singh (1994) contends that if the owners were made to pay for all the costs of livestock rearing they would drastically reduce the size of the herds, and keep only productive animals. In other words, the social cost of cattle ownership outweighs the private cost. If the divergence between the social cost and the private cost can be nullified, economic forces will take effect and reduce the number of livestock to a level where the total marginal cost of maintaining cattle will be same as or below the marginal value product. This hypothesis is confirmed by Nadkarni (1989) and reported by Singh (1994). In a case study in Karnataka, Nadkarni found that the value of the produce of unimproved cattle was Rupees 826 (US$ 39) per year per household. He also estimated the value of fodder consumed by the cattle, which came to Rupees 1,750 (US$ 83). The livestock owner did not have to pay for the value of fodder because the livestock grazed freely. Therefore, Nadkarni concluded that the loss to society, without accounting for the forest degradation that is caused by open grazing, and the cost of fencing agricultural lands necessitated by free grazing, was an average of Rupees 924 (US$ 44) per household.

The productivity of improved varieties of cattle is about 3,000 liters of milk per annum. At the prevailing price of

Rupees 5 per liter, the value of the output from a single cow is Rupees 15,000 (US$ 500) per annum (World Bank, 1992). Compared to the per capita income of Rupees 3,000 (US$ 100), a single cow can make a tremendous difference to the prosperity of the household. Singh (1994) explains that due to the high investment of buying improved cattle, more rural people do not own them. Improved cattle not only cost more but require high maintenance. They must be kept in an enclosed area and their diet supplemented with commercial feed. There is a perception of high risk, because without any insurance available, poor households are afraid of losing the entire investment if the cow dies. Pasha (1992) studied ownership patterns in Karnataka, and found that the number of livestock owned by the richer sections of the rural population were much higher than the poor, which supports the theory that the high risk and cost of owning improved livestock deter the majority of the rural people from such investment. This is a situation where a prospective profit making venture is facing an adoption problem. It must be addressed through risk reduction mechanisms by providing some form of insurance, and by providing credit facilities for improved cattle purchase.

The total livestock population of West Bengal, not unlike most other states in India, is very large. Along with it their fodder requirement is large, although availability of fodder is limited and has not increased significantly over time. The latest figures available from the 1982 census for the state of West Bengal, reported by the Committee on Fodder and Grasses (1987) show a livestock population of 15.9 million cattle, 1 million buffaloes, and 12.4 million goat and sheep. The growth rate of the livestock population in West Bengal comes out to 3.4% annually (census figures as reported in Ministry of Agriculture, 1992). About half of the total number of households in the state own some livestock or another.

Pasture and grazing land available for the above livestock is only 6,300 hectares (Ministry of Agriculture, 1992). The total livestock density in the state is 3.4 animals per hectare, of which the cattle density itself is 1.79 animals per hectare. Analysis using the available data indicate no relation between regional livestock density and the availability of pasture lands as explained below.

Comparison of the percentage of forest area and cattle density using cross sectional data for the 16 districts in West Bengal revealed the following results. With cattle density as the sole independent variable in a linear regression model trying to explain the variations in percentage of forest area, a significant negative coefficient for the independent variable with a correlation of 0.50 was obtained. This indicates that the density of cattle is inversely related to the fraction of area under forests, and therefore the density of cattle could be partially responsible for the reduction in forest area.

In determining the effect of cattle density and availability of pasture, a similar multiple regression analysis reconfirmed the inverse relation between cattle density and percentage of forest land, and also indicated a positive relationship between availability of pasture and area under forests, with a correlation of 0.51.

A model relating population density with cattle density showed a weak positive relationship (correlation of 0.19) between the two variables.

The mixed results of the above numerical computations raise doubts about the reliability of the data set. The figures used were produced by various departments of the government. The geographical and population dynamics are available from the Ministry of Planning and Statistics, while the forest sector data and the livestock data come from the Forest Department and Animal Husbandry Department respectively. In the case of data on land use, only those areas that underwent change from one land use to another and were reported to the relevant government authority, were accounted for. As a result, a particular forest area, after undergoing total degradation and bereft of all vegetation, continues to be included as forest area until it undergoes an official land use change. Data on cattle population is also imprecise due to the large number of unimproved cattle which are not accounted for.

Livestock require two kinds of fodder to survive. Cattle require equal quantities of dry and green fodder while goats require dry fodder only. The total fodder consumed by the livestock remains unknown because the unimproved varieties of animals feed on their own. However, the Committee on Fodder and Grasses (1987) report that the optimal diet for average unimproved cattle consist of 5 kilograms of dry fodder and 5 kilograms of green fodder every day. The diet for average sheep and goat consist of 0.4 kilograms of dry fodder only every day. Sarmah (Government of India, date unavailable) estimates fodder requirements using the assumption that animals consume 2% of their body weight daily, a method which yields consistent estimates of fodder requirements compared to the method used by the Committee on Fodder and Grasses.

Using these measures, estimates for the total requirement of dry and green fodder for the entire livestock population for the state of West Bengal could be estimated. However, the level of fodder shortage remains a moot point because the low productivity of the livestock raises important questions for livestock policy. Is it worthwhile from the standpoint of forest communities as a whole to maintain such a large number of unproductive livestock, and to invest in securing fodder for them? This issue is outside the scope of this research.

Nontimber Forest Products

The demand for nontimber forest products for subsistence purposes is difficult to define. Unlike domestic energy for which there is a threshold level required for cooking and keeping warm, even small quantities of nontimber forest products supplement the diets of the rural people and generally improve their overall standard of living. All nontimber forest products are collected and consumed directly, and no figures or estimates for their volume are available. Therefore, this research did not attempt to estimate the demand for nontimber forest products, although previously discussed literature asserts that rural communities traditionally depend on consumption of nontimber forest products, the dependence being higher for the poorer sections of the population.

CHAPTER V

DISCUSSION OF RESULTS AND POLICY IMPLICATIONS

The results of the estimation of future requirements and production possibility of fuelwood and industrial wood are presented below.

TABLE 5.1. ESTIMATED YEARLY PRODUCTION POSSIBILITY OF FUELWOOD AND INDUSTRIAL WOOD (in million tons)

PRODUCTS/YEAR	**1995**	**2000**	**2005**	**2010**
FUELWOOD	1.297	1.969	2.991	4.012
INDUSTRIAL WOOD	1.995	2.986	4.544	6.103

TABLE 5.2. ESTIMATED YEARLY REQUIREMENT OF FUELWOOD (in million tons)

	1995	**2000**	**2005**	**2010**
SCENARIO 1[2]				
POP.GR.RATE=1.34%	13.445	14.271	15.148	16.079
POP.GR.RATE=2.14%	13.985	15.441	17.048	18.822
SCENARIO 2[3]				
POP.GR.RATE=1.34%	12.221	11.772	11.348	10.940
POP.GR.RATE=2.14%	12.711	12.755	12.800	12.845

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[2] In Scenario 1, the income growth rate is assumed to be constant for all income classes. The population growth rates are weighted averages between rural and urban growth rates and represent growth rates of fuelwood users. The alternate population growth rates are projected rates and observed rates respectively.

[3] In Scenario 2, the growth rate of income is assumed to be skewed in favor of lower income classes.

TABLE 5.3. ESTIMATED YEARLY REQUIREMENT OF INDUSTRIAL WOOD (in million tons)

	1995	2000	2005	2010
POP.GR.RATE=1.4%	2.853	4.658	7.605	12.415
POP.GR.RATE=2.3%	2.971	5.053	8.591	14.606

TABLE 5.4. ESTIMATED YEARLY SHORTFALL OF FUELWOOD (in million tons)
(Availability-Requirement ratio in parenthesis)

	1995	2000	2005	2010
SCENARIO 1				
POP.GR.RATE=1.34%	12.148 (1:10.4)	12.302 (1:7.2)	12.157 (1:5.1)	12.067 (1:4)
POP.GR.RATE=2.14%	12.688 (1:10.8)	13.472 (1:7.8)	14.057 (1:5.6)	14.810 (1:4.7)
SCENARIO 2				
POP.GR.RATE=1.34%	10.924 (1:9.4)	9.803 (1:5.9)	8.357 (1:3.8)	6.928 (1:2.7)
POP.GR.RATE=2.14%	11.414 (1:9.8)	10.786 (1:6.5)	9.809 (1:4.3)	8.833 (1:3.2)

TABLE 5.5. ESTIMATED YEARLY SHORTFALL OF INDUSTRIAL WOOD (in million tons)
(Availability-Requirement ratio in parenthesis)

	1995	2000	2005	2010
POP.GR.RATE=1.4%	0.858 (1:1.4)	1.672 (1:1.5)	3.601 (1:1.7)	6.312 (1:2)
POP.GR.RATE=2.3%	0.976 (1:1.5)	2.067 (1:1.8)	4.047 (1:1.9)	8.503 (1:2.4)

Fuelwood

The enormous shortfall of fuelwood under all the different scenarios considered in the estimation, as apparent from Table 5.4, confirms that fuelwood shortage is the most pressing problem in the forestry sector. However, the availability-requirement ratio, which was 1:24 according to Chakrabarti (1989) shows an improvement in all the different scenarios considered. This implies that the growth rate of fuelwood production is higher than the growth rate of fuelwood consumption. Therefore, if this trend continues in the long run, it can be argued that fuelwood shortage will be eliminated. But this is not a valid argument for two reasons. First, even though the ratio is declining, the magnitude of the shortage is not necessarily decreasing. Therefore, the declining ratio only indicates improvement in a relative sense. Second, the production growth apparent in the above estimates is entirely due to the expansion of the forestry programs under more or less constant productivity, given by the current silvicultural technology. If productivity growth can not be achieved, this expansion will slow down and eventually end as the land constraint becomes binding. Therefore, the fuelwood shortage will not be eliminated without further policy interventions aimed at requirement reduction and/or productivity growth.

Population growth and income growth are the two variables that explain the change in fuelwood requirement in this analysis. Let us examine the effect of population and income growth rates on an estimated level of future requirement of fuelwood. In scenario 1, the growth rate of income has been assumed to be evenly distributed over all income classes of the population. In this scenario, the level of fuelwood requirement over time increases for both the population growth rates considered, the increase being more rapid in the case of the higher population growth rate, as expected.

The magnitude of shortfall of fuelwood in the case of the lower population growth rate remains more or less constant, although the availability-requirement ratio declines from 1:10.4 to 1:4, between 1995 and 2010, indicating improvement in a relative sense. The absolute level of shortfall increases in case of higher population growth rate, although the ratio declines from 1:10.8 to 1:4.7 during the same period. Therefore, reducing population growth rate is clearly a tool for reducing fuelwood shortage.

The second scenario assumes a higher income growth rate for the poorer section of the population, compared to the relatively richer section. In this scenario, under the assumption of lower population growth rate, the aggregate fuelwood requirement declines significantly over time. This is the only case among the ones considered where the absolute level of aggregate requirement shows a declining trend. Under the assumption of the higher population growth rate, the aggregate requirement is more or less constant over time.

The absolute level of shortage of fuelwood, in this scenario, drastically declines, even under the assumption of higher population growth rate. In the case of the lower population growth rate, the availability-requirement ratio declines from 1:9.4 to 1:2.7 in fifteen years, while under the higher population growth rate, the ratio declines from 1:9.8 to 1:3.2 during the same period. It is clear that effect of income growth of the poorer sections of the rural population has the maximum effect on the reduction of aggregate fuelwood shortage. This finding is very crucial for understanding the nature of the fuelwood problem and for developing policies to combat it. The suggestions for policy formulation are presented later in this chapter.

The enormous shortage of fuelwood is currently being met by two main sources (Saxena, 1994a). First, illegal removals from public forests are rampant. Second, other fuels such as shrubs, bushes and wastes, which are inferior to even fuelwood are being greatly consumed. The continuance of these methods to meet the shortage is both unsustainable and undesirable.

Industrial Wood

The requirement of industrial wood is estimated to increase rapidly, with the rate of increase being higher under the assumption of the higher population growth rate. The production of industrial wood is also expected to rise faster than the rise in the production of fuelwood. However, the rate of growth in estimated production is not higher than the rate of growth of estimated requirements. As a result, the shortage of industrial wood, both on an absolute, as well as a relative, scale, is expected to increase over time.

The availability-requirement ratio for industrial wood for 1990 is estimated by the Wood Balance Study to be 1:2. Results of his analysis indicate that initially, in 1995, the ratio drops to 1:1.4 under assumption of lower population growth rate and 1:1.5 under assumption of higher population growth rate. The magnitude of the shortage also drops marginally from 0.9 million tons to 0.858 million tons under lower population growth rate. However, under the two different assumptions of population growth rate, the ratio goes up to 1:2 and 1:2.4 respectively and the magnitude of shortage rises to 6.3 million tons and 8.5 million tons respectively in the year 2010.

All the explanatory variables considered in this analysis, income growth, population growth, literacy rate growth and growth in the manufacturing sector GNP, have a positive effect on the growth in the requirement of industrial wood. This is unlike the case of fuelwood, where income growth in the lower income groups led to declining consumption. Moreover, other than population growth, growth in all the variables is desirable for overall economic growth of the nation. Therefore, policies should not be directed to slow down the growth of these variables to reduce the growth in industrial wood requirement. On the contrary, the implication is that growth in the requirement of industrial wood is an indicator of overall economic development of the nation. Therefore, in general, reducing the estimated shortage should not be attempted by requirement reduction strategies as in the case of fuelwood.

Policy Implications

The policy implications for reducing the shortage of fuelwood and industrial wood that emerge out of the findings of this analysis can be divided into the following:

(i) policies to reduce population growth rate, which affect the level of requirement of both fuelwood and industrial wood,

(ii) policies to increase the income growth rate among the lower income rural population, which affect the aggregate requirement of fuelwood,

(iii) policies to promote more efficient use of fuelwood, which affect the aggregate requirement of fuelwood,

(iv) policies to promote fuelwood substitution by improved availability of fuelwood substitutes at "reasonable" prices,

(v) policies to open up competitive markets of industrial wood to promote adoption of Farm Forestry;

(vi) policies to increase the area under forest cover by promoting adoption of Farm Forestry and by wasteland reclamation,

(vii) policies to support research and development in genetics and silviculture, for forest productivity growth,

(viii) policies to reduce riskiness of Farm Forestry,

(a) by developing and transferring technical knowledge of tree production to private tree farmers to reduce production risk, and

(b) by developing and providing opportunities of price risk reduction to private tree farmers, such as forward contracting,

(ix) policies to support rural infrastructure building, such as the building of roads and communication facilities, electrification etc. which would reduce fuelwood consumption and promote adoption of Farm Forestry,

(ix) policies to develop training skills for foresters, required for initiating and supporting joint management and Farm Forestry.

We will look at each of these policy implications individually.

Population Growth Rate

Comparing the estimated requirement and consequent shortage of fuelwood (see Table 5.4) under both the scenarios considered, and in case of industrial wood (see Table 5.5), under the two alternative assumptions of population growth rate, it is seen that lower population growth rate significantly reduces the shortage of fuelwood and industrial wood over time. Therefore, one common policy thrust that will reduce shortage of both fuelwood and industrial wood over time is population growth reduction strategies. It is indeed gratifying to observe that a decline in the population growth rate has been forecast by both the Government of India and the United Nations. However, the projected growth rates are very optimistic and numerous critics have expressed caution in formulating policies based on the projected rates. Such reductions in population growth rate, if realized, could be greatly beneficial to the forestry sector. Population pressure on forests is particularly significant in the state of West Bengal, which is indicated by the per capita forest area of the state of 0.02 hectares compared to 0.12 for the nation.

Income Growth Rate

Income growth of the lower income group in rural areas reduces the fuelwood requirement, the reduction being more as the growth rate of income is higher. Income growth among the richer sections does not affect fuelwood consumption significantly because either (i) households belonging to that group already use superior fuels for their energy needs, or (ii) they continue to use fuelwood irrespective of their ability to purchase superior fuels, a behavior which may be attributed to tradition or habit. It is clear from the results of this analysis that income growth among the poorer sections plays the dominant role in reducing aggregate fuelwood consumption.

Income growth increases the requirement of industrial wood, although literature asserts that after sustained long term income growth, the level of income reaches a threshold beyond which superior wood substitutes are used and wood consumption declines. Therefore, income growth on the one hand would reduce fuelwood requirement, but on the other hand, increase industrial wood requirement. However, income growth is certainly desirable for the following reasons:

(i) reduction of fuelwood requirement should be given high priority because it has been established that fuelwood crisis is the most pressing problem of the Indian forestry sector. Of the total wood consumption in West Bengal, 88% is in the form of fuelwood,

(ii) income growth is an indicator of the growth in the standard of living of the population, and

(iii) the multiplier effect of income growth would enhance the nation's various development efforts, some benefits of which will potentially result in reduction of population growth rate and improvements in forest management and productivity, thereby contributing indirectly to reduction of industrial wood shortage.

Income growth among the poorer sections in the rural areas can occur due to

(i) increased net returns from agriculture, which primarily depends on increase in productivity. The production of rice, the predominant crop in West Bengal, has grown at an annual rate of 7% over the last decade. However, as reported in Chapter 1, the net returns are low compared to the national average. Further agricultural intensification by the promotion of more productive cropping material, fertilizers and improved irrigation leading to higher cropping intensity, and effectively higher annual productivity per unit area, would lead to higher net returns.

Prospects of sustained growth in agricultural productivity in West Bengal is possible only if improved technologies can be adopted on a regular basis. Increased cropping intensity, expansion of high yielding variety of seedlings used, and increased fertilizer use are all dependent on availability of water. According to the Ministry of Agriculture (1992), the potential area under irrigation in West Bengal is 5.5 million hectares, of which 2.3 million hectares could be potentially covered by medium and major irrigation schemes, while 3.2 million hectares could be covered by minor irrigation schemes. Of the potential area under major and medium schemes, about 65% of the area has been covered so far, while only 50% of the potential area under minor schemes has been covered. Therefore, there is scope for the development of irrigation. However, the development of major irrigation schemes and increased fertilizer use have become increasingly difficult due to recognition of the negative externalities that arise (Lele et al., 1994). Moreover, the rate of growth of public investment in agricultural development has slowed down in almost all developing countries. The scope for development of minor irrigation facilities shows maximum promise in West

Bengal, and is crucial for sustained growth in rural incomes.

(ii) increased employment opportunities including off farm employment opportunities. Only 30% of the population in West Bengal was classified as workers in 1991. In the last decade the number of agricultural workers has increased by 2.5% annually while off farm employment has increased by 3.3% annually. Some of this growth is offset by the rural population growth rate of 2.11% annually over the last decade. Increased employment opportunity not only provides the workers with income to purchase improved fuels but the increase in opportunity cost of labor due to increased employment opportunities makes fuelwood collection unremunerative. The dual effect reduces fuelwood consumption. It must be noted, however, that the price and availability of alternative fuels affect the rate of substitution due to increased income. If prices of substitutes also rise as incomes rise, the rate of substitution will be lower. Emphasis on employment generation policies, therefore, is needed. West Bengal has lately shown promise towards rapid industrial growth by successfully providing improved infrastructure and attracting outside investment. The combined effect of income growth due to agricultural and industrial development is certainly the most important policy tool for forest sector development.

Efficiency of Fuelwood Use

Literature asserts that the thermal efficiency of improved fuelwood stoves is three to four times higher than traditional stoves. Clearly, widespread adoption of improved stoves would reduce aggregate fuelwood consumption drastically. However, a four times more thermal efficient stove does not imply that fuelwood consumption is reduced by 75%. Reliable information on fuelwood saved due to adoption of improved stoves is not available in the literature. Concrete research results are needed, based on which the exact magnitude of the effect of widespread adoption of improved stoves on aggregate fuelwood requirement could be estimated. Intensifying policy thrust towards promotion of improved stoves is certainly a relatively low cost activity which should be pursued.

Availability of Substitutes

It has been established in the literature presented in Chapter 2 that substitution to kerosene is higher among households located closer to the government kerosene outlets. The average distance to a rural outlet in West Bengal is 2 kilometers. The irregular availability reduces the incentive for making the 2 kilometer trip. Therefore, promotion of an increased number of outlets and the regularizing of supply, would lead to reduction in aggregate fuelwood consumption by promoting fuelwood substitution. In case of irregular availability of substitutes, the entire income effect will not be realized.

Opening up of Markets

Due to lack of access to markets, private tree growers have to go through middlemen, as a result of which there is a large difference between the price that consumers pay and the growers receive, as established by Saxena (1992). Therefore, net returns to the grower are lower, which deters adoption of Farm Forestry. Direct access to markets would eliminate middlemen, increase profits, and instil confidence in the minds of the growers in performing this activity. Open markets also lead to improved information and help to ease the regional gluts and shortages, which stabilize the price and reduce perception of price risk.

Increase in Forest Area

Production growth can be achieved either by bringing in more land under production, or by technological advances leading to productivity growth.

The potential for increasing the area under productive forests lies in Farm Forestry. The area under Farm Forestry considered in this analysis consists of land already identified by the Forest Department for potential adoption and consequent production. However, Farm Forestry can spread further, and may even be justified on some marginal lands which are currently under crop farming. The deterrents to the adoption of Farm Forestry were discussed in Chapter 3. The main impediments are market opportunities for small farmers, research and development of appropriate species and transfer of technical knowledge to tree farmers. Further policy emphasis is needed to develop programs in these areas, which are discussed separately.

Increasing the area under public forests is possible to a certain extent if the enormous area which currently falls in the category of wastelands could be brought under forest cover. However, restoration of these low quality lands is time consuming and would need heavy investment. In return, their productivity will be low.

Growth in Productivity of Forests

Other than increasing the area of forest land, production growth can be achieved by productivity growth. Unfortunately, the National Forest Policy is mainly concerned with ecological revival and the provision of subsistence goods, and does not strongly emphasize productivity growth (Lele et al., 1994; also see Appendix II). However, productivity growth is essential too.

It is more difficult to increase the productivity of natural forests unless their "natural" characteristics are reduced over time. However, productivity growth in plantation forests can certainly be enhanced. As Saxena (1992) points out, the hybrids of Eucalyptus used in India have genetically deteriorated and their productivity is low. He calls for the development and propagation of genetically improved seedlings and experimenting with other exotic species which have the potential for higher productivity under different ecological regimes of India.

Risk Reduction

The risk perception among tree farmers consists of production risk and price risk. Policies to reduce production risk should aim to develop programs to transfer the technical knowledge developed by the research community and the Forest Departments to private tree farmers. Such programs exist in West Bengal which support Farm Forestry operators. Further risk reduction will be achieved if good quality research can develop more productive hybrids, and if the efficiency of the transfer process is improved.

To reduce price risk, well developed markets, where the grower has direct access, need to be developed. Further risk reduction can be achieved by developing schemes for forward contracting with the industries. This is consistent with the 1988 Forest Policy which supports the industries linking up with individual farmers and providing them with support to grow trees. The industries do not support this approach and prefer to be allowed to produce their own wood in leased lands (Lele et al., 1994). Therefore, a policy environment for developing a forward contract scheme involving the industries does not currently exist. However, the adoption of Farm Forestry will be greatly increased if provision of technical support and a system of price guarantees can be established.

Infrastructure Building

The provision of infrastructure such as roads and communication facilities would lead to reduction of the forest products shortage in a number of ways. First, it would open up employment opportunities in neighboring towns, increasing the income and opportunity cost of labor and thereby reducing fuelwood consumption. Second, it would provide easier access to obtain fuelwood substitutes such as kerosene from government outlets. Private tree growers would be able to move their produce to markets more easily, increasing their net returns. Improved communication would lead to more information on price and market conditions based on which farmers could make more informed decisions. This would positively affect the adoption of Farm Forestry.

Rural electrification would reduce the use of fuelwood for energy, although the cost of electricity relative to the purchasing power of households would be the deciding factor. However, the superiority of electricity as a source of energy will act as an incentive to switch.

Training

The issue of training of foresters according to the needs of the new forest sector programs was discussed in Chapter 3. The success of both community management of forests and Farm Forestry greatly depends on the assistance of the foresters in the design and implementation of the programs. Therefore, it is imperative that the foresters are well trained in the relevant areas. It is apparent in the literature that a well developed scheme for imparting such training does not currently exist. Policies directed towards developing such schemes are crucial.

Emphasis on Provision of Subsistence vs. Commercial Forest Products

Fuelwood consumption constituted 88% of all wood consumption in 1990, according to the Wood Balance Study. The magnitude of fuelwood shortage was eleven times more than the magnitude of industrial wood shortage at that time. Under these conditions, emphasis of the 1988 Forest Policy on the provision of subsistence forest products over commercial forest products could be justified. However, estimated future requirements of fuelwood and industrial wood indicate that the growth in requirement is more pronounced in the case of industrial wood, which is expected in a rapidly developing economy as in India. When the estimated industrial wood requirement for the year 2010 is compared to the estimated fuelwood requirement under Scenario 1, the requirement of fuelwood is only 1.3 times more than the requirement of industrial wood. Under Scenario 2, industrial wood requirement exceeds fuelwood requirement by a factor of 1.13.

This finding is particularly important from a policy perspective. It implies that the policy emphasis should shift over time towards provision of industrial wood. As discussed above, sustained increase in production of industrial wood requires (i) bringing more area under production through promotion of Farm Forestry and removing all impediments for adoption of Farm Forestry, (ii) wasteland reclamation, (iii) productivity growth by developing new hybrids and successfully transferring the technology to the field, and (iv) developing competitive markets which will reflect the increasing scarcity of industrial wood through price signals, which will translate to increased adoption of farm Forestry and eliminate the excess demand.

Due to the long gestation period of forests, it is imperative that the shift in priority towards policies that promote industrial wood production are anticipated early and are acted upon so that the possibility of damaging shortages is avoided.

The main findings of this research and their important implications for development of the forestry sector are applicable to the state of West Bengal in particular, and to the rest of India as well as other developing countries facing similar problems, in general. The following chapter looks at the effects of forest management on the environment and how they affect us.

CHAPTER VI

ENVIRONMENTAL CONCERNS

Forests and the Environment

Deforestation affects the forest communities directly by reducing the availability of forest products which are used by the community members for both subsistence and some income generation. However, negative externalities also exist, which indirectly affect the forest communities significantly and the rest of the population of a larger region to a certain extent. The externalities arise as a result of deforestation affecting the quality of the environment, which in turn affects the people. The major thrust of policies and programs has been on the direct effects of deforestation on the local communities. However, effects on the environment should also be given careful consideration, because compared to other sectors, forest sector development programs take much longer to yield results due to the nature of forest systems. As a result, delays in program implementation result in prolonged periods of suffering and require higher levels of investment and effort to counteract the continued decline.

The total value of forest resources to humans is difficult to measure. The main difficulties are due to:

(i) nonmarket nature of forest product consumption due to which price as a measure of value is not available, and (ii) externalities which result in divergence between private cost and social cost of forest products.

However, there is an additional difficulty in valuing forest resources. As Dasgupta (1993) explains, even if markets existed and were perfect and all externalities could be internalized, one would capture only the known use-value of a resource. As it happens, its shadow value may well exceed the known use-value. The reason is that there are additional values embodied in a resource stock. One additional value, applicable to living resources, is their intrinsic value as living resources. It is almost impossible to measure intrinsic worth.

Another source of value arises from uncertainty in their future use-value and irreversibility in their use, as in the case of natural forests. Even if social well-being functions were neutral to risk, it would not do to estimate the shadow price of an environmental resource solely on the basis of the expected benefit from its future use. Irreversibility in its use implies that preservation of its stock has an additional value, the value of extending society's set of future options. Future options have an additional worth because with the passage of time more information is expected to be forthcoming about the resource's use value. This additional worth is often called the option value. The true shadow price of a resource is the sum of its use-value and option value.

Effects of Deforestation on the Environment

Absorption of Pollutants

Deforestation has greatly contributed to making India's environment less clean and more unhealthy over the decades. The quality of air in many cities of India is far below the permissible limit for a healthy life. As a result, chronic illness has gone up drastically, though it is difficult to measure the cause and effect precisely. Air pollution is not confined to the cities. Natural constituents of the atmosphere like sulphurdioxide and carbondioxide can become pollutants after the tolerance level of the atmosphere is exceeded. Deforestation directly reduces the tolerance level for carbondioxide because trees absorb the gas and produce oxygen. Literature asserts that every hectare of woodlands absorbs 3.7 tons of carbondioxide and produces 2.5 tons of oxygen annually (Pokhriyal and Natiyal, 1991). The primary pollutants are sulphur oxides, carbon oxides, nitrogen oxides and hydrocarbons. A secondary pollutant--ozone--forms through photochemical reactions among primary pollutants and natural gases. Combustion of fossil fuels and smelting of ores generates sulphur and nitrogen oxides which combine with water in the atmosphere and come down as acid rain. Excess carbondioxide in the atmosphere is greatly responsible for the greenhouse effect (Tewari, 1991).

The only way to reduce the excess carbondioxide from the atmosphere is its absorption by trees which produce oxygen in return. Therefore, although deforestation is not responsible for emission of carbondioxide, it affects the balance by reducing the ability of forest lands to absorb the gas.

Marshes and forested wetlands are part of the forest system. They too have pollutant absorbing capacities. Reduction of such areas leaves the water bodies with excessive amounts of urban waste, fertilizer, pesticide, oil spills and industrial chemicals, and results in water pollution and ultimately may lead to eutrophication.

Erosion Control

Forests conserve the top soil against wind and water erosion. Swaminathan (1982) asserts that while it takes anywhere between 100 and 400 years for one centimeter of top soil to be formed in nature, all this soil can be lost in just one year because of erosion. In India, the loss of topsoil in 1972 was an estimated 6,000 million tons resulting in loss of soil nutrients equivalent to 2.5 million tons of nitrogen, 2.6 million tons of potassium and 3.8 million tons of phosphates (Swaminathan, 1982 and Dasgupta, 1987). In 1985, the estimated loss had doubled to 12,000 million tons (Poffenberger, 1990c). Four million hectares of land have been badly gullied and ravined due to erosion and this is suspected to be increasing at an alarming rate of 8,000 hectares every year. The debris generated during road and other construction activities are often negligently left without properly stabilizing them, resulting in soil erosion (Mukerji, 1991).

Among the problems leading to soil erosion, particularly in the hilly areas of the northern part of the state, timber operations on steep slopes loosen the soil much more than on flat ground, due to the force of gravity. Wind and rain aggravate the situation and cause landfalls which strip a much larger area of vegetation than that covered by the timber operation. Much of the eroded soil ends up as silt in rivers. Mountain rivers collect much silt while flowing down the valleys before reaching the plains. To avoid eroded soil from reaching the rivers, an effective method is to leave a band of trees undisturbed on both sides of mountain rivers and streams. This small conservation measure could pay rich dividends in the form of erosion control. Similar methods can be applied to protect the erosion of soil in the form of dust along roadways.

It has been estimated that nationally 80 million hectares of land under cultivation require attention from a soil conservation point of view (Swaminathan, 1982). The Ganges river carries an estimated 586 million tons of eroded top soil annually. Sedimentation at the current rate is believed to reduce the water storage capacity of reservoirs by 1 to 2% annually (Poffenberger, 1990c). This affects the productivity of the hydropower and irrigation projects. In most of the large multi purpose irrigation projects, siltation has been much higher than predicted at the project formation stage. It has been 50% more in the Bhakra Project, 300% more in the Ram Ganga Project and 400% more in the Pong Project (Mukerji, 1991). Siltation also cause floods which have increased strikingly in the last few decades. An average of 9,000 hectares are affected by floods annually, which is 14 times more than the 1950 average (Tewari, 1991).

Measuring the Effects of Deforestation on the Environment

The effects of deforestation on the environment are difficult to measure at the regional level because they manifest themselves through a chain of ecological and natural processes and the end results are scattered over a larger region. There are a few indicators, however, which convey the magnitude of the regional situation. Among them is the extent of soil erosion, area of wastelands, wildlife population census and the net area under different types of forests. In West Bengal, according to the 1981-82 statistics of the government (Indian Agriculture in Brief, 24th edition), which is the latest available, severe soil erosion affected 1.033 million hectares of land. In addition, 3.27 million hectares of land has been officially registered as being degraded in some form or another. The total "problem area", as the government calls it, adds up to 4.3 million hectares. Compared to the total geographical area of 8.875 million hectares, the problem area covers an alarming 48% of the state. Of the 4.3 million hectares that need to be treated for recovery, only 377,000 hectares or about 9%, were attended to till 1989-90 when the seventh plan ended (World Bank, 1992). That leaves a balance of 3.92 million hectares that require treatment.

Policy Responses

According to the National Forest Policy of 1988 and subsequent government legislation, clear felling of natural forests has been stopped. This legislation, however, does not address the problem of gradual degradation of forests caused by routine extraction of fuel and fodder in unsustainable quantities by the forest communities. Participatory Forest Management seems to be the best alternative among the programs available that attempt to minimize the degradation of natural forests. In West Bengal, the harvesting is done manually and the timber is moved in small trucks. As a result, the negative side effects of harvesting operations on the soil and the remaining forest is kept to a minimum. Logging operations are totally suspended during the rainy season.

Biodiversity and Wildlife Conservation

Biodiversity refers to the range of plant and animal species existing in a region. However, the range of species becomes meaningless unless their population is above a threshold that would assure their long-term survival. For example, all good zoological parks maintain a certain diversity of animal and plant species, but are of little value from the standpoint of maintenance of biodiversity, except in special cases such as for naturally extinct species. Therefore the key to biodiversity conservation is to ensure maintenance of enough habitat for diverse animal and plant species that naturally occur in that area.

India has traditionally been rich in its flora and fauna. Along with the forests, their denizens have disappeared. The most striking of the animals, the Cheetah, fastest animal on earth, became extinct earlier this century. The national animal of India, the Indian Tiger, with an estimated population of 40,000 at the turn of the century, was on the brink of extinction when Project Tiger was established in the early 1970s. A population of less than 2000 was protected at that time (Dasgupta, 1987). The tiger occupies a position at the top of the food chain in an ecological sense, and its downfall is a clear indication of the downfall of other life forms which make up the ecosystem. The reduction of forest lands has ousted wildlife from their home and that constitutes a serious blow to the delicate ecological balance on which all life forms on this planet, including humans, are totally dependent.

This loss of habitat has global repercussions too. Migratory birds which come to India find their winter home missing. The number of rare Siberian Crane wintering in India has sharply declined (Dey, 1984). Birds that habitually nest in large colonies find their nesting grounds disappearing.

The topography of West Bengal extending from the Bay of Bengal in the south to the Himalayan mountains reaching up to 14,000 feet in altitude in the north, allows a wide and rich diversity of flora and fauna. Among the protected forests in the state of West Bengal, the largest is the mangrove system of the Sundarbans, covering an expanse of more than 200,000 hectares. This area is a National Park, a Wildlife Sanctuary, a Tiger Reserve, a World Heritage Site and a Biosphere Reserve. The unique mangrove ecosystem, with a number of endemic species and subspecies of flora and fauna, is protected carefully and attracts tremendous national and international attention.

The Buxa Tiger Reserve and the adjoining forests in the sub-Himalayan ecosystem is also important from a biodiversity conservation standpoint. These forests, however, have a number of forest villages inside the protected areas. Attempts are being made to relocate some of these villages, although finding adequate funds for that purpose has been a problem. Some mining activity continues in this area, which the Forest Department has been unable to stop. Due to deforestation in certain patches, the forest areas in the region have been disconnected from each other. This is a serious disadvantage for the wildlife population. Since some of the lands between adjoining forest areas have been privatized, compensation would have to be paid to acquire those lands to be maintained as wildlife corridors.

Among the other important forest systems from a biodiversity standpoint, are the forests in the north west foothills. The Neora Valley forest system consists of pristine forests with unique ecosystems. In the same area, forests including Gorumara and Chapramari provide good wildlife habitat, although the human population in the adjoining farming communities and tea gardens is quite dense. There are no protected forests in the south western part of the state, although a few areas have been identified for possible wildlife sanctuaries.

Wetlands provide an invaluable habitat for a large number of species of aquatic birds, and specially to the large flocks of migratory birds which arrive every winter, in addition to the other functions described earlier. A comprehensive survey of all major wetlands in the state is required in order to understand their ecological functions, including provision of habitat for birds.

However, West Bengal also has three times the national average of population density (West Bengal: 6.15 per hectare; national: 2.16 per hectare), a forest cover of only 13.4% compared to about 19% nationally, and a per capita forest area of 0.02 hectares compared to 0.12 hectares nationally. Of the total recorded forest area of 1.18 million hectares in the state, only 70% or 840,000 hectares are truly under forests. Of this, about 300,000 hectares are significantly degraded (Ministry of Environment and Forests, 1991). In many of the forest areas, for example in the hills of the north, clear felling of natural forests and their replacement with monoculture plantations of quick growing, low value timber species have continued for the last few decades (Poffenberger, 1990a). This has had serious negative effects on the biodiversity and wildlife habitat of the region. Although with better understanding of the importance of natural forests, the practice of developing monoculture plantations to replace natural forests has been discontinued. However, wildlife habitat continues to shrink, as overexploitation of forest lands and resultant deforestation continue (World Bank, 1992).

The shrinkage of habitat, in addition to reducing the wildlife population, also forces some of the animals to venture outside the forest when their population exceeds the carrying capacity of the forest. A good example of such a situation in West Bengal is that of wild elephants coming out of the forests into neighboring villages and farmlands, and on certain occasions, proceeding to nearby urban areas. Elephants consume a sizable quantity of vegetation every day, and require a large per capita forest area for survival. They also migrate from one forest area to another, seasonally. Reduction of forest area, coupled with the destruction of corridors used by the elephants for migration, make them wander into human territory. A good example is the impact of the Subarnarekha Dam in Bihar, which was built without any consideration for its effect on the wildlife in the nearby Dalma Wildlife Sanctuary, and the migratory corridors between Dalma and forests in south west West Bengal routinely used by elephants. The total number of people killed by wild elephants in the state increased from 39 in 1986-87 to 82 in 1990-91. More than Rupees 2.5 million (US$ 80,000) is spent annually to compensate the people for damage caused by elephants, with most of the compensation going for damage to agricultural crops and property. This striking example is an indication of the seriousness of the problem.

Substantial funding, to the tune of Rupees 30 million (US$ 1 million) annually, is available for the development and implementation of wildlife conservation projects from both the state and national governments (World Bank, 1992). These funds are being used constructively for the maintenance of wildlife sanctuaries and other protected areas, and for the control of illegal hunting and wildlife trade, as well as for nature education programs for the general public. The crux of the matter, however, remains the maintenance of enough habitat of good quality for the diverse plant and animal species to thrive on.

Deforestation is not only the disappearance of trees--it is also the taking away of much of the unique and rich natural resources with which India has been endowed. Some of these resources in turn are used to save human life--50% of modern medicines come from the natural world. An estimated 1400 forest species may have anti-cancer properties (Myers, 1983).

CHAPTER VII

CONCLUSION AND INFORMATION AND RESEARCH NEEDS

Participatory Forest Management

The future of forest management in West Bengal may not rest in the hands of Participatory Forest Management as we see it today. The reasons for that are twofold. First, although the Forest Department and the forest communities are working together to manage the forests, the two groups certainly do not have the same objectives in mind. The National Forest Policy (1988) is based on the government's view that to protect public forests and provide for subsistence needs of the rural communities, cooperation of the forest communities in managing the public forests is needed. On the other hand, the forest communities hold the view that participating in the management of the forests will not only enhance the supply of forest products for their use but also provide them with employment opportunities in forestry operations and a share of the revenue from harvesting, which would not have been available to them otherwise. The cash income, in particular, is of great attraction to the rural community, as it can be argued that their marginal utility of income at low income levels is high. Therefore, whereas the motivation of the

Forest Department comes from the protection and provision of subsistence goods, the motivation for the participating community members comes from income generation possibilities. Although in spite of this basic difference the two groups have agreed to work together, the conflict of interest remains embedded and has the potential to threaten the sustainability of the system in the long run.

Second, as the results of this analysis show, poverty alleviation is the key to sustained forest protection by the forest communities because with higher income, not only will there be fuelwood substitution, but the dependence on other nontimber forest products will also decline. As a result, the provision of forest products for subsistence needs will cease to be an issue of concern. In that situation, new objectives of the Forest Departments may not be consistent with involvement of the forest community in public forest management.

The above arguments indicate that Participatory Forest Management as is being developed today is only a temporary system to tide over the current crisis till the other sectors of the economy raise the average standard of living of rural populations to a level at which they will not have to directly depend on forests for any of their subsistence needs. However, the management system during this period of transition is important because (i) it must prevent irreparable damage to the natural forest systems in the short run, and (ii) the duration of the transition period, which depends on the pace of overall rural development, is unknown and the subsistence needs of the rural poor must be met from the forests during this time.

Plantation Forestry

The results of this study indicate that the emphasis of forest sector policy must change from provision of subsistence to provision of industrial wood, in the next fifteen years. Natural forests, which have an intrinsic value in the form of existence value and option value, as described earlier, are not appropriate for large productivity growth attempts. Therefore, growth in plantation forestry, which is a production system much comparable to crop farming, must keep up with the growth in requirement of industrial wood over time.

The situation of plantation forestry as it exists today may be compared to the Indian agricultural sector just before the Green Revolution. The area of culturable waste lands in West Bengal, as in most other states, is large. The fertility of soil is sufficient for tree plantations. However, the area under production and productivity remains low. Just as the Green Revolution boosted agricultural productivity by a combination of transfer of modern technology and sound economic policy, a similar revolution in the plantation forestry sector that would provide a quantum jump in the productivity of these plantations, is required.

Unlike participatory management of natural forests, the establishment and growth of these plantations is not transitional in nature. Moreover, productivity growth must be sustained over time to keep pace with the increasing requirements. In addition, the ability of these plantations to effectively supply the growing needs over time will keep the pressure off the natural forests. Therefore, the key for natural forest protection, and all the environmental benefits of such protection, lies in the success of sustained growth in plantation forestry.

Information and Research Needs

Lack of quantitative information is the biggest drawback for researchers in Indian forestry. The only data available is usually from various government departments whose interpretations are often difficult and of limited use. For example, information from the Ministry of Agriculture indicates that the total area under forest cover in India increased steadily from 1950-51 to 1989-90, the latest year for which data are available. However, the increase is entirely due to internal transfer of classification of public lands and does not reflect increase in forest cover. Recent landsat imageries have shown that much of the area reported to be under forests is not forested at all.

It is interesting to contrast the classification system used to describe agricultural and forest lands (Romm, 1981). Agricultural lands are typically described by the crops they grow, yields they produce, water and soil regimes, size of tenure and farm operations. They indicate productive use. The forest lands are described as protected, reserved, unclassed forests, fallows, pasture, etc. and do not indicate current use, productivity, etc. They are for property jurisdiction only.

There is a need to classify forest lands and common property lands according to their capacity to respond productively to investment. The lands can be ordered according to their economic potential, forming a schedule of best to worst investment possibilities. Ecological criteria, and technical and economic assumptions are necessary but insufficient for capability assessment of forest lands and common property lands, because the level of human interaction must be accounted for. Therefore, population density, and the extent to which areas have been reached by market systems and public services must be taken into account. Incentives for investment depend on the difference between the expected net returns from new practices and the actual returns from the present ones. Information on the value of present use is therefore essential for the land to be ranked according to investment possibility classes.

Literature on forest management in India is vast and growing at an increasing rate. However, most of them are applied research results, based on experiments or experiences at the micro level. Although many of them convey a good idea of down to earth issues involved in forest management, usually they cannot be generalized to be used for other studies. Applied research that can be used for design of policies and programs, depend significantly on the availability of basic research results. The latter is noticeably lacking in India.

A set of basic research that is urgently needed for estimating the production possibility of forest products is technical information relating the growth potential of selected trees to the soil and climatic conditions of different regions. As a result, the supply of forest products for nonsubsistence uses can not be estimated with adequate precision. It also hinders selection of species with particular characteristics that would make them suitable for certain regions and for specified uses.

Provision of fuelwood is of prime importance for forest policy. However, a prerequisite of better fuelwood policies is an improved information base on which policies would be based. Among the most pressing needs are better data on household energy use, on fuelwood markets, on the fuelwood resource base, and on plantation management systems. Much has been written about how households respond to energy scarcity and which factors are important in influencing their fuel choices, but little empirical information exists. A number of household surveys have been undertaken, but most are surveys at one point in time. These do not give any insights into the processes of change, the specific character of localized fuelwood production and use, and the nature of the interaction between the people and the resource base. Data on patterns of fuel use and rigorous estimates of demand and supply elasticities are almost nonexistent. There will be little confidence in the predictions of how households will respond to changing fuelwood situations until this information is available.

Investment in information gathering and applying data to quality policy oriented research will certainly be worthwhile for developing long-term forest management systems.

Summing Up

To sum up, the forestry sector in West Bengal is putting up a bold fight against deforestation, although the shortage of fuelwood and industrial wood has been increasing and expected to continue, unless forces from outside the forestry sector reduce the increasing subsistence requirements. Therefore, development forces outside the forestry sector hold the key to the survival of the forests in the state. In particular, sustained growth in rural income due to developments in both the agricultural and industrial sectors is crucial. During the period of transition towards such development, Participatory Forest Management in public forests and intensive tree farming in private lands appear to be steps in the right direction.

APPENDIX I

THE ARABARI EXPERIMENT

In 1972, a small group of forest officers in West Bengal developed a pilot project of Participatory Forest Management in the Forest Range of Arabari (Bardhan Roy, 1990). The forest officers had noticed that the forest community was greatly dependent on forest products from the neighboring forests for their daily subsistence needs. The forests were protected by forest guards who were not very successful at it, nor in preventing exploitation. On the other hand, along with the steady increase in population density, the extraction of different forest products by forest community members was significantly degrading the forest. As a result, over time the intensity of extraction was on the rise to maintain the consumption level of resources from the forest, but in spite of that, along with the state of the forest, the standard of living of the community was declining. The officers realized that the situation was going from bad to worse.

The Forest Range of Arabari is located in the south-west part of the state in the Midnapore district. The forest is of the tropical dry deciduous type, comprising mainly of Sal in various stages of degradation due to overexploitation, grazing and fire. The project involved eleven villages with a total population of 3607 persons in 618 families. The total area of degraded forest land under the pilot project was 1250 hectares, which consisted of a 185 hectare refractory area unfit for tree growing (Bardhan Roy, 1990). Therefore, the net area available for regeneration was 1065 hectares.

Initially, the forest officers sought the co-operation of the village community through a number of informal meetings. The community members were told that they would be allowed to collect leaves, twigs, and branches for fuelwood and grass for fodder free of charge for their own consumption. They were also promised some employment in other afforestation and enrichment activities which were planned in the same region. The Forest Department would decide on the harvesting date but 25% of the proceeds were to go to the community members. During harvesting, the community members would be hired to provide the labor. In return, the community was responsible for protecting the forest from illegal extraction or any unreasonable exploitation.

After the project was reviewed in 1986 there were about 1000 hectares of well stocked forest cover. It was decided that 97 hectares or about 10% of the regenerated forest could be harvested annually. The net revenue from the harvest operation in 10% of the area was substantial, amounting to Rupees 936,500 (US$ 55,000). Besides greatly increased availability of fuelwood and non timber forest products which were directly collected by the households, a 25% share went to the community, while about 50% of the harvesting cost paid by the Forest Department went to community members who were hired as laborers. The annual income per family amounted to Rupees 978 (US$ 60).

The Arabari experiment has been accepted on a worldwide basis as a success story of joint forest management. The "Arabari model" is being widely replicated.

APPENDIX II

NATIONAL FOREST POLICY 1988

The Minister of Environment and Forests presented the National Forest Policy 1988 to the Indian Parliament in December 1988 and outlined its salient features. The minister recognized that contrary to expectations, earlier policies had failed to maintain India's forest cover, and the new policy "will be able to achieve nature conservation and ecological balance at the same time meeting the essential requirements of the people."

The primary goals were to:

(i) maintain environmental stability through preservation and restoration of ecological balance,

(ii) conserve the remaining natural forests and protect the vast genetic resources for posterity,

(iii) meet the basic needs of the people, especially fuelwood, fodder and minor forest products,

(iv) protect the customary rights and concessions on the forests of the forest dwellers.

The approaches to be followed were

(i) protect and improve productivity of existing forests and forest lands,

(ii) extend the sanctuaries, national parks and biosphere reserves in order to protect biological diversity,

(iii) actively involve local people in protection, conservation and management of forests.

The goals and approaches summarized by the minister clearly indicate dramatic changes in the management of India's forests. The primary focus of the policy is on ecological revival of the forests. Environmental stability and maintenance of ecological balance are the main goals. The policy even goes on to say that direct economic benefits from the forests must be "subordinated" to the principal aim, and criticizes the "tendency to look upon forests as revenue earning resource."

The broad objectives of the Policy aim at the preservation of bio-diversity and the genetic resources including wildlife management, checking soil erosion, flood and drought control, increasing the forest area in the country to cover one-third of the geographical area through massive afforestation and social forestry on degraded lands, meeting the fuelwood, fodder and nontimber forest products requirements of the rural population, and increasing overall forest productivity but encouraging wood substitution at the same time. These objectives should be met by a "massive people's movement with involvement of women."

The 1988 Forest Policy outlines the current aims and objectives of forest management and approaches that are to be taken. But it does not specify the mechanisms by which the objectives could be met. The overall reaction to the Forest Policy has been positive but skepticism has been expressed with regard to numerous implicitly conflicting goals and how they could be reconciled. The body of the dissertation addresses some of these problems. It must be noted that the status of the policy statement is such that its contents are not enforceable through the legal system.

APPENDIX III

THE DESIGN OF FOREST PROTECTION COMMITTEES IN WEST BENGAL

Participatory Forest Management in West Bengal is a joint management scheme involving the Forest Department and the local community members grouped into Forest Protection Committees. The composition, duties, functions and benefits for the Forest Protection Committees have been standardized in West Bengal, and are as follows (Bardhan Roy, 1992).

Composition

The Divisional Forest Officer in consultation with the village Panchayat Samiti (local government) selects members of the Forest Protection Committee, normally from economically-backward households living in the vicinity of the concerned forest. The Panchayat Samiti provides necessary support and help to ensure the smooth and proper functioning of the various activities of the Forest Protection Committee. An executive committee is formed, consisting of representatives of the Panchayat Samiti, Forest Department and up to six elected representatives from the local community. The Forest Department assists in drawing up a constitution for the Forest Protection Committees.

Duties

The Forest Protection Committees maintain detailed records of their members, copies of which are sent to the Forest Department. The minutes of all meetings, including executive committee meetings, and an annual general meeting, are also recorded and sent to the Forest Department. The Forest Department and the Forest Protection Committee jointly determine a microplan which outlines the specifics of forest management to be practiced. Microplans focus on the linkages of the available resources and required investments with the needs of the community.

Functions

The primary function of the members of the Committee is to ensure protection of the forest area from any illegal encroachment in accordance with the Indian Forests Act and the Wildlife Protection Act. They would inform the Forest Department if any person attempts to trespass and willfully or maliciously damages the forest, and assist the Forest Department to apprehend the offender. All members of the Committee should be involved in protecting the forest and other duties may be assigned. The Committee shall be consulted by the Forest Department to select the workforce for all forestry operations in the area, and will ensure smooth and timely execution of the operation. The Committee shall also assist the Forest Department during harvesting of the forest produce, and in the proper distribution of the pre-determined portion of the net sale proceeds among the members of the Committee.

Benefits

A share of the net sales proceeds from each harvest of a selected portion of the forest area will be given to all members of the Forest Protection Committee who have participated in this program for at least five years. Harvesting shall not be done unless the trees are at least ten years old and the Forest Department determines that they are ready for harvesting. A share consisting of 25% of all fuelwood and poles harvested will accrue to the Forest Protection Committee members. The share of the poles will be distributed in cash while the share of the fuelwood will be in kind.

The Committee members are entitled to collect most subsistence products in reasonable quantities without any charge. This includes fallen twigs and leaves for fuel, fruits, flowers and seeds for their consumption and grass for fodder. Some commercially viable products such as Sal seeds and Kendu leaves may be collected but sold through cooperatives at predetermined prices. Medicinal plants can be collected only on the basis of microplans to ensure ecological sustainability.

Failure to comply with the conditions agreed upon by the Forest Protection Committees and the Forest Department will lead to penalties determined by the Forest Department in consultation with the Committee members, and would usually entail cancellation of the individual's membership among other penalties.

APPENDIX IV

ESTIMATED ANNUAL PRODUCTION POSSIBILITY UNDER DIFFERENT FORESTRY PROGRAMS

TABLE A.1. ESTIMATED ANNUAL PRODUCTION POSSIBILITY UNDER DIFFERENT FORESTRY PROGRAMS
(Area in '000 hectares; Production in million tons)

PRODUCT	**AREA**	**1995**	**2000**	**2005**	**2010**
PARTICIPATORY MANAGEMENT					
INDUSTRIAL WOOD	705.4	0.74	1.23	1.84	2.46
FUELWOOD	705.4	0.58	0.97	1.448	1.93
FARM FORESTRY					
INDUSTRIAL WOOD	856.2	1.11	1.5	2.25	2.99
FUELWOOD	856.2	0.63	0.86	1.28	1.71
STRIP PLANTATIONS					
INDUSTRIAL WOOD	185	0.15	0.26	0.45	0.65
FUELWOOD	185	0.085	0.15	0.26	0.37

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